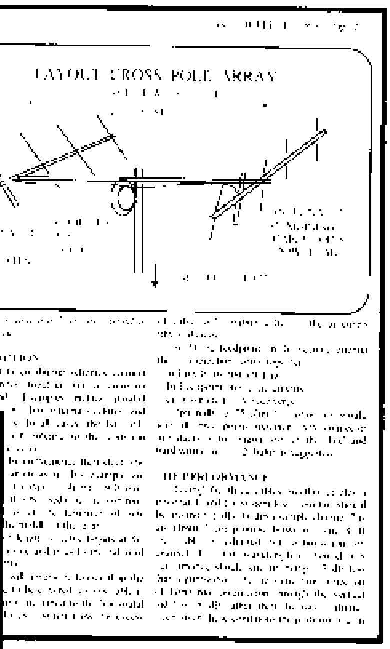
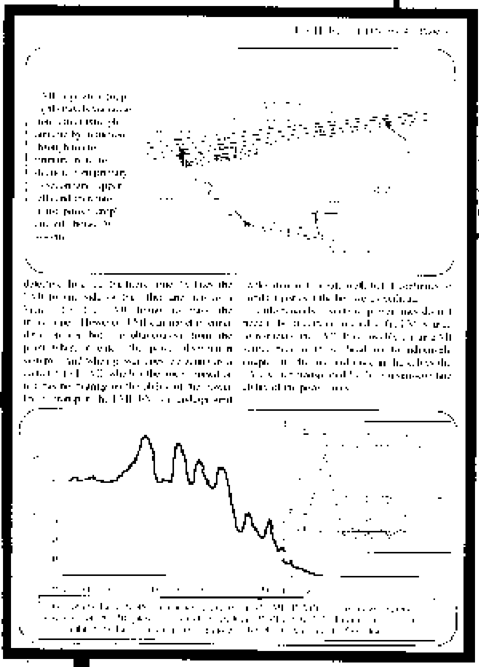
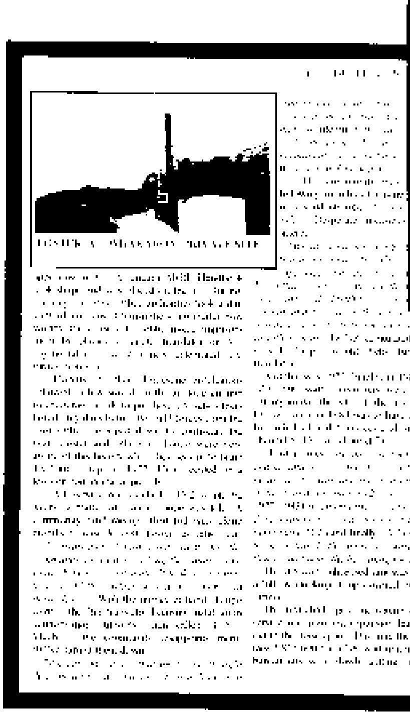
COMBINING CROSS POLE SIGNALS



BEATING NOISE





TAUPO'S SOLUTION TO NO TV3

TECH BULLETIN 9304 / ISSUED 15 SEPTEMBER 1993

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A FEW WORDS FROM THE PUBLISHER

... LEARNING FROM THE PAST ... NUMBERS ... COOP's TECHNOLOGY DIGEST ...

In March of 1977 the Secretary of the (NZ) Broadcasting Corporation was (Mr) Keith Hay. TV1 was available to most New Zealanders; TV2 (then called South Pacific Television) was available only in major centres. Taupo was from 5 to 7 years 'down the list' to have TV2 coverage. Taupo television technician Ian Foster (Lakeland Sight & Sound Ltd) knew TV2 signal was available on selected hilltops surrounding Taupo. He also knew how to get it down into town. Unlike the Broadcasting Corporation, Foster was ready to do it; then, in March of 1977.

In the spring of 1993, many portions of New Zealand remain without TV3 service. Perhaps Foster's 1977 answer to TV2 (followed with modifications in 1990 when Taupo also started TV3 ahead of its neighbouring communities) will inspire you to do something about the lack of TV3 coverage in your area. It's in this issue.

While researching this report we ran across a musty notice in ROG (RFS) files written by Keith Hay early in March 1977; the same month Taupo began its TV2 'pirate' translator service. The 1977 policy regarding the annual Broadcast Fee is surprisingly current with today's New Zealand On Air policy. We thought you'd enjoy reading in context what Hay wrote more than 16 years ago:

"The license fee is legally payable for the right to operate a receiving set and has never been related, in either radio or television, to the extent or quality of the service available in a particular locality. The concept of a variable license fee has been examined in the past and rejected as neither equitable nor practical. If the cost to the individual is to relate to the standard of service he receives, in fairness to all, it must also relate to the cost of providing him with that service. On this basis many provincial or rural license holders would be liable for a fee up to forty times that which could be justified for viewers in urban areas close to major transmitters. In practical terms they could receive no service at all if its costs were not largely borne by those more fortunately located. The most equitable approach, therefore, is to charge a standard fee and allocate the revenue obtained to provide the best service for the greatest number of viewers.

"The impracticality of the concept of a variable license fee lies in the massive increase in administrative costs it would entail. A specialist staff would have to be engaged to access comparative standards from district to district and a complex system of rebates and surcharges would have to be applied as standards were improved in a particular locality, or when the holder of a license moved from one class of reception area to another. In the final analysis, all this additional expenditure would have to be met by the broadcasting revenue, and would necessitate a substantial increase in the license fee." 1977 ... 1993; TV2 ... TV3. "Those who fail to learn the lessons of history are doomed to repeat it."

Page 36, Tech Bulletin 9303: column 3, lines 8 and 9 should be corrected to read "...for 700 metres is 108.95km; 191.32 km total length if...".

Our companion publication **Coop's Technology Digest** for 20 September reports the real limitations of fibre optic technology in New Zealand; and, updates the blinding speed at which digital video compression is developing. Don't miss out on these important reports. If you did not receive a FREE sample copy of Coop's Technology Digest for August, write or FAX us today. A very small quantity of this digital television issue remains available.

TECH BULLETIN 9304
EMI CAUSES AND CURES

Any type or class of receiver receiving any format of modulation can be adversely affected by Radio Frequency Interference (RFI). Any type or class of transmitter can generate RFI. There is no such thing as a receiver or a transmitter which is 'RFI proof'.

In fact, any device operated by electricity (whether from AC power mains or a self contained battery) can be a 'transmitter'; even an incandescent light bulb. The list of 'possible' transmitters is virtually as endless as a complete list of every device conceived by man to operate from electricity; and that includes objects you would never associate with transmitting. A coffee jug, a washing machine, a light switch dimmer control - like thousands of modern 'gadgets', each has the potential to generate radio signals. Even machinery that does not operate directly from electricity, such as a gasoline fired combustion engine, produces often large amounts of radio transmission 'noise'.

If these 'families' of potential RFI generators were not enough to render purposeful reception impossible, there are still more sources of RFI. A totally passive object such as a farmer's shed covered with galvanized tin has the electronic ability to act first as a 'receiver' for two or more local radio signals, and then to act as a 'mixer' of these two (or more) signals creating yet a third (brand new) radio signal that is the mathematical sum (or difference) of the two (or more) 'mixing radio frequencies'.

Even nature itself creates RFI. A thunderstorm within 200 km will generate 'noise' on fringe and near-fringe TV signals in band I; on band III signals within 50 km and on band IV/V signals within 20 km of the storm. A heavy rain pounding on a rooftop television antenna will often 'charge' the TV antenna with static electricity. This 'static' appears as a steadily increasing amount of 'picture snow' on the screen over a period of time spanning 10 to 90 seconds. Then, suddenly, 'zap' the picture is clear (the static has discharged back into the atmosphere or to ground) and the noise slowly builds up again to repeat the cycle.

Any signal which degrades the desired reception could be classified as RFI. Your job is to first determine the nature of the interference, then to determine how it is getting 'into' the receiver or electronic system, and finally to locate the source of the noise and either repair the fault at the origination end, or filter out the interference at the receiver. That's what this issue of Tech Bulletin is all about.

THE TRANSMISSION OF EMI

Radio Frequency Interference (RFI) may in fact be TVI; Television Interference. Or, it might be interference to a stereo system, interference to an intercom system or even a telephone. The catchall term for all forms of interference is Electromagnetic Interference; EMI for short.

EMI can travel from its source to the point or points where it creates damage via any of three routes:

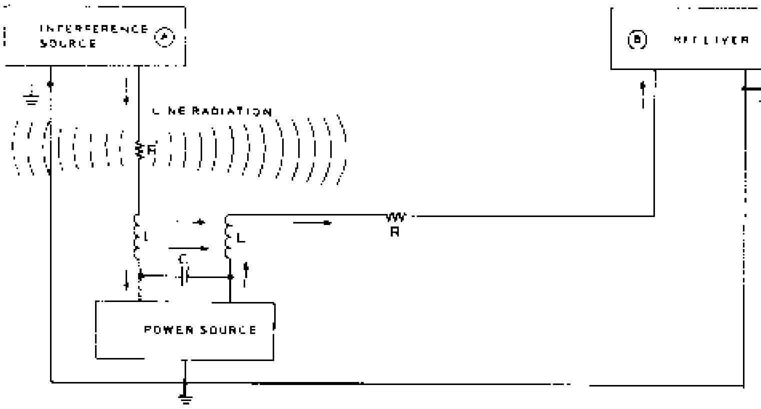
1) Radiation: Through the air ('ether') just as a radio or TV signal propagates,

2) Conduction: Traveling through some sort of wired network, such as the power lines,

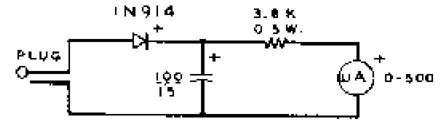
3) Induction: By magnetically 'coupling' between either its source and its target, or by 'coupling' from a conductor (power line) to a target (inside of a stereo set) having first penetrated the target device by being conducted 'inside'.

Because they go everywhere, power lines are the primary 'conductor' of EMI. An interference source can be conducted or 'induced' into an overhead power line and then be carried several kilometres by the power line. Tests we shall describe tell you quickly the power line is carrying the EMI; only a bit of skillful detective work allows you to 'backtrack' the EMI along the power line to its actual source. When power lines act as 'conductors' for EMI, they are often

RFI: Direct source radiation, power line coupling/transmission, and inductive coupling



QUICK noise level meter; plugs into earphone jack on receiver



incorrectly blamed as being a 'cause' of EMI. While it is true that power lines can generate EMI, more often they are merely the messenger.

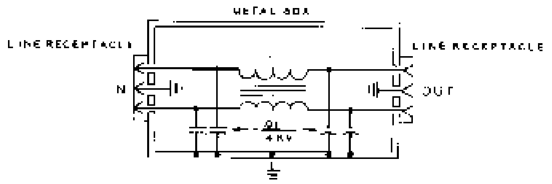
HOW IS IT GETTING IN???

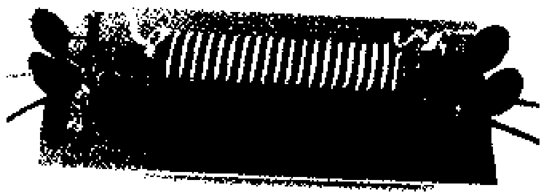
Even before you know what is causing the interference, you should determine how it is getting into the device displaying the interference (such as a radio, a stereo set, a TV set). By knowing how it enters the 'appliance' you will begin to eliminate possible sources of the EMI, and, narrow down to a handful the number of optional 'fixes' you can employ to cure the problem.

A radio (AM or FM), a TV set typically has two or fewer 'outside wires'. One of these plugs into the AC mains, another would connect to an aerial external to the set. The EMI energy may be entering the affected set through the AC mains lead, through the antenna wire, or in situations where the EMI source is physically quite close to the affected unit, directly into the circuitry of the unit by radiation that originates outside the cabinet.

The easiest 'outside wire' to disconnect is the aerial-antenna lead. If the EMI ceases when the lead is disconnected, you can probably safely assume the AC power mains is not the EMI conductor. If the signal persist when the aerial lead is disconnected, the next most likely path into the unit is the AC mains lead. Unfortunately as you unplug the lead not only will the EMI go away but so too will the desired signal(!). At this point you must temporarily modify the AC line circuit with a purpose-built line filter designed to trap (stop) EMI from being passed through on the mains line.

SAMPLE (basic design) LINE FILTER





Simple line filter. Dual winding coil wound on ferrite rod (J.W. Miller FR-500-7.50 or Amidon R61-050-750. Wires (no.18 gauge) are wound in parallel, on notched core at same time. Ends held in place with twine, epoxy. Mount in metal enclosure with suitable mains plug/socket. Ferrite rod 10 cm long, 12.8 cm diameter. Capacity 500 watts.

In this worst case scenario, if after the temporary addition of an EMI filter and the disconnection of the external aerial you still have EMI, you are down to two possibilities:

1) The EMI is radiating directly into the chassis of the electronic unit, through the case, and into one or more receiver stages. If this is the case, we'll see how you isolate the EMI and stop it. Or,

2) *You have just entered the Twilight Zone.*

Let's take these a path at a time. EMI entering via the aerial lead may be coupling into the antenna proper (at the far end of the line), or, it may be coupling into the actual downline. A ten metre downline run of coaxial cable (i.e., ten metres long from rooftop antenna to back of TV set) is a pretty common installation. Unfortunately, this is also a length which fits the wire length for antennas for three popular amateur (ham) radio bands; the 40 metre band (where the line would be a quarter-wave long), the 20 metre band (1/2 wave long) and the ten metre band (a full wavelength). Given the 'wrong' (or right) conditions between the TV antenna and the back of the TV set, this ten metre (give or take a metre in practice) length of RG-59 or RG-6 coaxial cable becomes an unintentional 'antenna wire' for the amateur 40, 20 or 10 metre bands. Now the TV viewer has an unwanted 'resonant' antenna (the lead in wire) for the neighborhood ham transmitter in addition to having a transmission line for his TV signals. The ham signals are efficiently scooped up by the near resonant 10 metre length of cable and fed directly into the TV set. Nothing good will happen when the neighborhood ham fires up his rig.

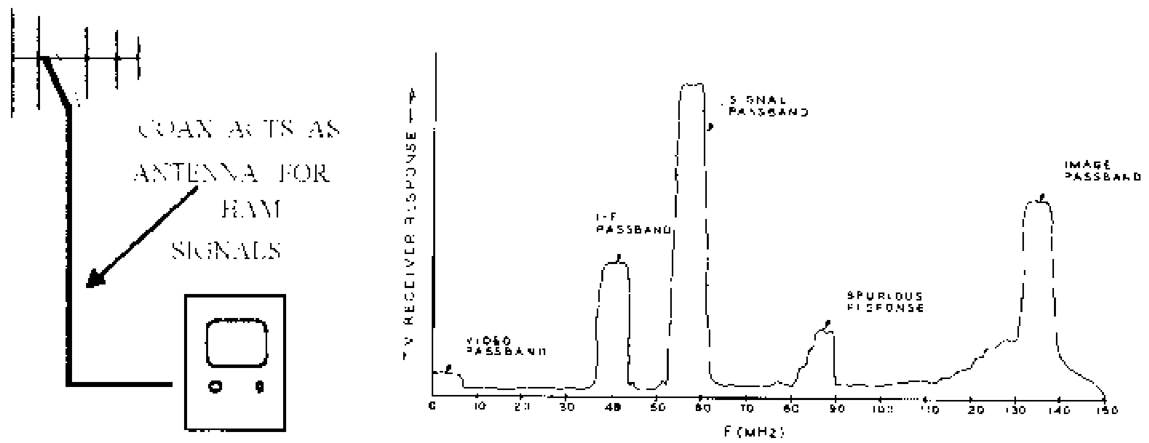
In this example, if the EMI stops when the TV antenna line is disconnected at the TV set, we have a straight forward problem. Shooting the ham is not one of our options.

Consider now a multi-piece stereo system: the pride and joy of its new owner. After digesting four separate manuals, running six different patch cords, and suspending the 20 pound speaker enclosures from hooks on the wall, this is one happy guy or gal. Until there is a blast of EMI that drowns out Neil Sedaka.

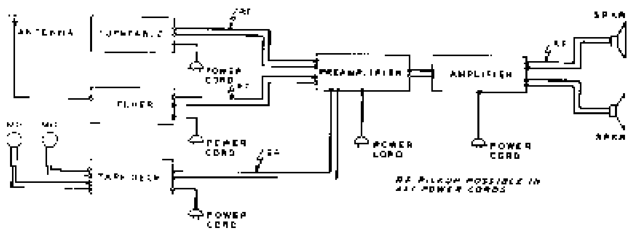
A multiple piece stereo system teaches the technician how to use logic. Whereas the TV set or radio had at most two 'outside wires', this Japanese branded Taiwanese-distributed and Malaysian manufactured set of four units has 14 outside wires, aptly described in its Hong Kong printed installation manuals.

Logic. It separates you, the professional, from the guy down the street with a Dick Smith VOM and a an AC mains tester.

Start with the one electronic piece common to everything in the system; the amplifier. And, the

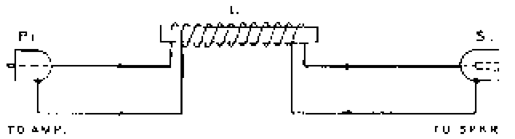


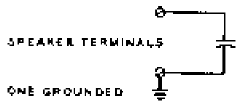
TV RECEIVER TUNED TO CHANNEL TWO HAS MANY OPEN WINDOWS FOR NON DESIRED SIGNAL INGRESS



STEREO SYSTEM: pull plug; RFI fades gradually? EMI coming in through audio device. RFI fades abruptly? RFI through AC mains. Volume control has no effect? RFI into system after volume control via low-level stage.

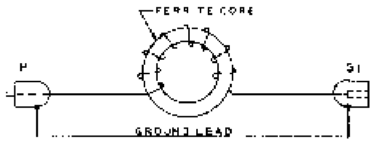
SPEAKER LEAD FILTER





DON'T DO THIS with solid-state stereo amps; OK with tube amps. Capacitive load may cause ultra-sonic oscillation destroying amp.

AMP INPUT LINE FILTER



one passive piece also common; the speaker (system). Disconnect at the back of the amplifier first one speaker plug, then the other. How do you know if the EMI has ceased or not if the speakers are disconnected? Listen on your stereo earphones using the jack on the front of the amplifier. Why not just listen on the earphones for the EMI and forget the speakers?

Good question. Because those usually long speaker leads your client ran down the wall and across the room make a wonderful antenna. It's not (just) the EMI sound in the speaker we are chasing; it is the method by which the EMI is being captured and then carried into the stereo system. If by unplugging one speaker lead the EMI stops, you may safely deduce the speaker lead itself is an antenna and through it the EMI is inducted into the stereo system amplifier.

So OK, after disconnecting both speakers you still have EMI. That leaves 10 more cables to check. Perhaps the EMI only occurs when they are using the CD player, or the cassette deck? That's an obvious clue which set of leads to try next (or first).

When you have everything disconnected but the AC line, and the problem is still there, we are back to your portable AC mains line filter. The next stop is direct radiation into the guts of the stereo set; not a pleasant option as we shall see.

Returning to the speaker leads (which experience shows will be responsible for the EMI pickup in roughly 50% of all stereo system cases), let's say we found the EMI went down significantly when the right channel speaker was disconnected. It goes away totally when the left hand side is disconnected.

Plug the right side back in and then disconnect it again; this time at the speaker end. If the EMI stays at the same level with the speaker disconnected but the speaker wire connected at the amplifier end only, you've found at least one EMI antenna; the amplifier to speaker cable. Now repeat this with the left hand channel speaker. We'll show how to fix it separately.

If disconnecting the speaker from the far end of the lead does reduce or eliminate the EMI, that says the speaker itself is the EMI antenna. This doesn't happen very often, but it can. A solution will be shown..

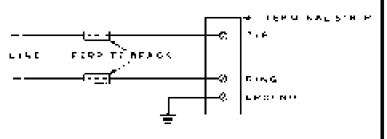
In each case we are taking one step at a time to determine just which wire or cable or line going into or out of the stereo system is either acting as an EMI antenna (picking up the directly radiated signal), or acting as an EMI conductor (carrying the EMI signal into the unit from the actual antenna). The 'fix' varies with the pathway of the EMI.. And just because a speaker wire is nominally a 'goes-outa' line carrying amplifier signal voltage to the speaker does not mean that it cannot also act as a 'goes-inta' for the EMI signal voltages as well. We'll return to EMI signal tracing; for now, having determined just 'how' the EMI is getting into the equipment, we are ready to go out and look for the EMI source.

NOT OBVIOUS

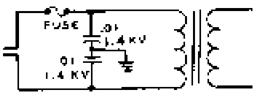
A backyard filled with masts, a metal tower laced with metres of aluminum tubing and a car parked in the driveway spouting more shafts than an American porcupine is probably a ham radio operator (or your customer lives next door to the Iraqi Embassy). When the EMI you hear or see switches on and off in a rhythm suspiciously like Morse Code, or you hear muffled talking from the demodulated EMI source, chances are you have a ham interference problem. This is not to selectively pick on hams; they cause relatively few problems. But most have a difficult time avoiding blame because of the profile of their antenna system. If your interference is a ham, you won't have much billable time tracking down the actual EMI source.

Most hams know at least as much about EMI reduction as you will know on your first few EMI service calls. Listen and learn from them. If they can demonstrate that the TV set in their house is clean of interference, that their AM/FM radio has no 'break through' and their stereo operates just fine even when they are on the air, chances are you are not being mislead when they insist *"I am clean"*. Let's see why this could be true while your client three doors down the street can't separate Neil Sedaka from Donald Duck.

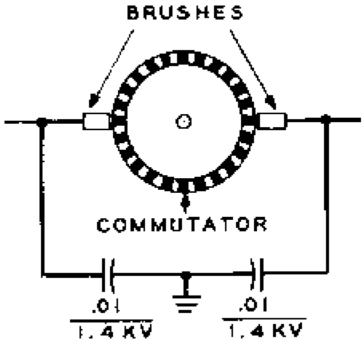
Almost no AM, FM, TV or stereo part manufacturer accepts any responsibility for his equipment not functioning 'show room perfect' in a busy 'radio environment. Almost no manufacturers design TV receivers, FM or AM



TELEPHONE / RFI PROOFING



BYPASSING AC MAINS



BYPASSING MOTOR

Bypassing is done with VHF-UHF rated ceramic disc capacitors (1.4 / 1.6 kV rated). Lead length is important since leads have series-resonating self-inductance and should be kept to absolute minimum (2-3 mm). Telephone line filtering using ferrite beads slipped over leads as shown; Amidon FB-75-101 (beads) with permeability of 5000.

receivers, or stereo component parts and systems to function in the presence of a strong radio signal field. You can prove this to your own satisfaction by checking either the schematic or the inside of the chassis where the AC mains line comes into the unit. The very first step any manufacturer will take to prevent EMI sources from sneaking into a receiver or amplifier via the AC mains is to place a pair of disc ceramic capacitors from each hot side of the AC line to chassis ground as a means of coupling DC energy (RF) to chassis ground. At the manufacturing level these discs, installed, seldom add more than ten Kiwi cents to the cost of a product. And as you will see, perhaps 25% of all stereo interference can be fixed, quickly, with the addition of two disc ceramic capacitors. Logic should suggest to you that if the manufacturer is unwilling to spend this first ten cents to avoid customer EMI problems, he certainly is not going to spend the next 'dollar' in cost which in most cases at the manufacturing level would allow you to move your client's offended stereo system right into the 'ham shack' down the street and still have it function perfectly.

Having made the point that few manufacturers will go to the trouble and expense to EMI-proof their consumer units, the additional point should be made that many manufacturers will, upon request, provide **(a)** parts, **(b)** advice, or **(c)** actually perform the work for EMI proofing once a particular situation is brought to their attention. The steps to take to learn this are:

1) Know the model number of the offended unit, go to the distributor/importer. Describe the problem and ask if they have any technical advice.

2) Will they provide the parts if you do the work?

3) Alternately, will they install the parts and still honor the warranty (assuming the unit is new enough to retain this protection).

NOTE: If service people who have found importers/distributors to be helpful with EMI correction data and/or parts will send along reports to Tech Bulletin, we will publish a list of these helpful people from time to time as a guide to brand names and models taking their customer satisfaction responsibility seriously.

It costs you little to make enquiry and you could be pleasantly surprised. In those

SOME OF MANY HARMONIC PROBLEMS

FM STATION HARMONIC

TV CH.	Harmonics From
1	30m ham (5X)
2	27 MHz CB, 10M ham (2X)
3	15m ham (3X), 40m ham (9X)
4	FM (2X)
5	FM (2X)
6	FM (2X), 27 MHz CB (7X)
7	FM (2X), Cordless fones (5X), 10M ham (7X)
8	10M ham (7X), 101-104.5 MHz 2-way (2X), Cordless phones (6X)
9	104.5 - 108 MHz 2-way (2X)
10	Ch. 2 TV (4X)
11	12m ham (9X), Ch. 2 TV (4X), Ch. 1 TV (5X), 10m ham (8X)

HARMONIC INTERFERENCE (2X, 3X, 5X etc. operating frequency) varies as a function of where in TV channel passband the interfering carrier falls. Near video, colour, audio (sub) carriers creates the worst interference. In-passband harmonics must be fixed at transmitter.

EMI FROM 'A TO 'X'

Air conditioners, air purifiers, arc welders, broadcast stations, bottle warmers, butter keepers, cash registers, culture incubators, Christmas decorations, dental drills, diathermy machines, deodorizing lamps, doorbell transformers, electric fences, elevators, electronic games, fish tank thermostats, flashing signs, fryers, food mixers, food mixers, gasoline engines, germicidal lamps, garbage disposals, gas furnace blowers, gas range and dryer igniters, hair dryers, heating pads, ignition systems, induction heaters, intrusion detectors, light dimmers, loose fuses and lamps, lightning arrestors, movie projectors, mercury arc rectifiers, neon signs, office machines, oil furnaces, pest control devices, power lines, plastic molding equipment, printing presses, relays, RF heaters and welders, radio receivers, refrigeration equipment, security transmitters, scanner receivers, sewing machines, shoe repair machines, sign flasher buttons, soldering machines, slot car racers, sterilizers, spot welders, synchronous converters, SCRs, traffic control switching systems, thermostats, tractors and trucks, ultraviolet systems,vacuum cleaners, waffle cookers, walkie-talkies, washing machines, x-ray machines and hundreds of things that operate from electrical or fossil fuel energy.

Any device with moving contacts (i.e., relay), a rapid ramping voltage (i.e., SCR), a fast pulse time (i.e., computer), a step shifting voltage or installed out of doors can generate EMI. The airwaves are polluted and growing more polluted daily!

internal-to-chassis problems and fixes to be described, having assistance from the manufacturer (passed through the importer /distributor) can be very helpful.

If the source of the EMI problem is not jumping out at you (the neighborhood ham being an example of this; a customer living directly below the tower of 1ZB would be another obvious case), more detective work is required.

First, does the EMI appear to be an 'intelligent transmitter', or, simply an interference source? Virtually all 'intelligent transmitters' convey information: they are modulated. The modulation itself is a powerful clue and if you can demodulate it, you are halfway to finding the source.

If we have an 'intelligent transmitter' involved, it has an assigned operating frequency. Can you determine a mathematical relationship between the assigned frequency and the interference?

An FM broadcast station operating between 97.5 MHz and 100.0 will have a second harmonic (fundamental frequency times two) between 195 and 200 MHz; TV channel 7. A ham transmitter in the amateur ten metre band (28.0-29.7 MHz) will have a second harmonic falling between 56 and 49.4 MHz (TV channel 2). A harmonic is a multiple of the primary (intended) transmission frequency. An FM broadcast transmitter with 60 dB of 2nd harmonic suppression will still radiate nearly 1/10th of a watt on the second harmonic if the primary frequency power is 50 kilowatts. That's enough power to cover an area several miles across with devastating interference to TV channel 7 (TV channels 4-7 fall within the FM broadcast second harmonic region). Depending upon the design of a transmitter, and its output coupling circuit plus antenna system, the second (fundamental X2), third (X3) and fifth (X5) harmonics are usually the most troublesome.

If you can locate the frequency (by tuning around with an TV FSM for example), even if only approximately, write down the suspected harmonic carrier frequency. Now divide it by 2, then 3, then 5 to see if the answer comes close to being a frequency you can identify as a potential interference source. There is a special case where two or more frequencies 'mix' in a passive device (the fabled cow shed with tin siding mentioned earlier); we'll discuss that separately.

'Intelligent transmitters' are least difficult to source. The real troublesome sources are not intelligent but your intelligence may be taxed to locate them.

NOT SO OBVIOUS

Whereas an intelligent transmitter occupies a specific frequency, non intelligent EMI tends to be broadband in nature. Start your lawnmower and place an AM/FM portable radio next to the combustion engine. Tune through the AM band: the 'popping' noise of the spark plug firing is heard quite evenly through the entire band. Switch to FM; the noise will probably be present, at a considerably reduced level, but still throughout the band regardless of where you tune. This is broadband noise.

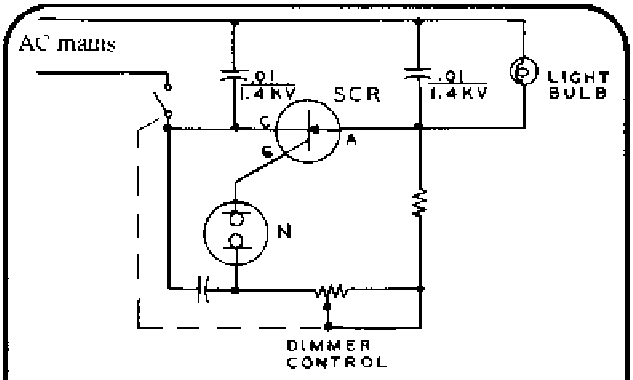
All combustion engines rely upon a voltage jumping between two metallic contacts for firing energy. The jumping spark is electrical energy, rich in its own harmonics. That energy ignites the fuel mixture, and, radiates away from the engine via the ignition system wiring harness. Any arcing voltage, jumping from one metallic point to another, creates RF energy.

Or to put it another way, where there is a voltage you have an energy source seeking ground. The voltage will follow the path of minimum resistance on its way to ground. And ground may be some distance away (such as in an AC electrical distribution system) so having a less than ideal resistance (i.e., high resistance) through which it must flow is only a temporary impediment to the electricity.

The typical household is awash in electrical devices with less than perfect (high resistance) grounds. Some devices are designed around the principal of purposeful resistance since the appearance of resistance in a circuit causes the electricity to enter an altered (useful by design) state.

Consider an electrical light dimmer control. If a light bulb has been designed to function at full brilliance when connected to 230 vac, it will function at proportionally lower brilliance with lower AC voltages. One simple way to reduce the brilliance is to place a resistance in series with the flow of AC. Another technique is to use an SCR (silicon controlled rectifier) in a 'chopper' circuit, switching from a very high impedance to a low impedance in unison with the AC hertz rate. The switching time is fast (typically a microsecond) and fast switching time equates to a rich field of harmonics.

The (now rare) mechanical metallic wiper arm and resistive surface designs have two mating metallic surfaces. After some use the surfaces deteriorate; corrosion, mechanical wear and poorly chosen metals all contribute to the product's decay. When the two metallic surfaces no longer smoothly mate (if in fact they did when brand new) the AC current flow through the device becomes erratic. It begins to arc and just like the spark plug arc this arcing creates EMI. The SCR versions generate EMI from day one; it is inherent in their fast switching speeds.



Silicon controlled rectifier (SCR) is RF bypassed with .01 1.6 (1.4) kV ceramic discs across input and output circuits.

Imperfect flow of AC electricity in any electrical device that results in arcing also results in EMI. When the brushes on a refrigerator motor become worn or dirty, when the contacts on an electric stock fence become corroded, when the contacts on an electric door chime become pitted or corroded ... arcing and EMI.

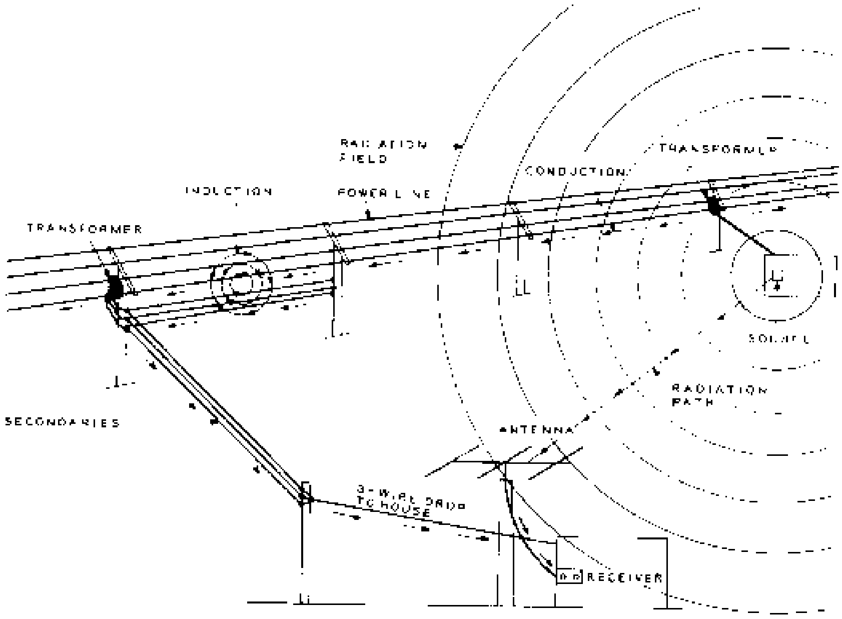
EMI, as you can understand, is all around us.

FINDING THE SOURCE

Not all EMI radiates directly from the source. If the EMI source is connected to the AC distribution system (as most are; combustion engines being an exception), power wiring becomes both a conductor (i.e., transmission line) and an antenna (radiator) for the EMI. That's the bad news.

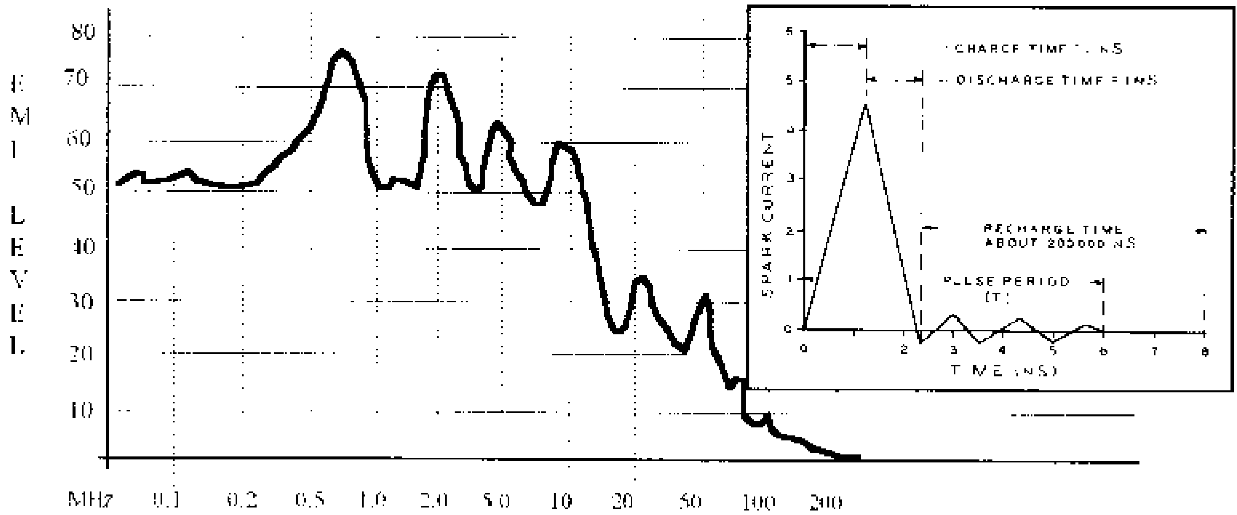
The good news is that few forms of EMI are capable of passing through a power transformer and this is a valuable tool for you; the EMI

EMI originating (upper right) travels via radiation (direct through air) and by induction through mains primary: note induction from primary to secondary (upper left) and then into house power 'drop' and into house AC system.



defective. In effect the transformer 'isolates' the EMI to one side or the other and acts as a 'sump' for the EMI trying to pass the transformer. However, EMI can travel in either direction (or both simultaneously) from the point where it enters the power distribution system. And when power lines are acting as a conductor of EMI, whether the line is buried or not has no bearing on the ability of the power line to transport the EMI. EMI on underground cables may not radiate well, but it continues to conduct just as if the line were overhead.

Unfortunately, overhead power lines do not need to be directly connected to the EMI source to re-radiate the EMI. It is possible for an EMI source near to an overhead line to inductively couple into the line and once in the cables the EMI is then transported by the transmission line ability of the power lines.



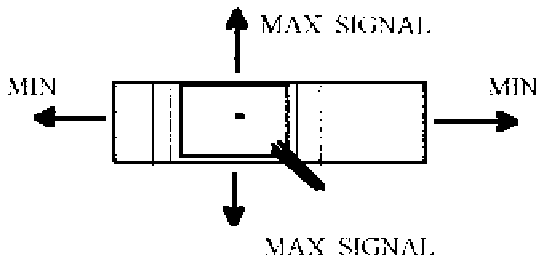
CORONA (discharge) NOISE distribution spreads through LF/MF/HF/VHF diminishing as frequency increases. Note 20+ dB spikes, one occurs between 40 and 50 MHz; band I TV channel 1. Inset: corona oscillatory discharge. Pulse train near 6 nanoseconds with 100 Hz rep rate for 50 Hz line.

One of the most useful tools in tracing EMI to its origin (there may be nothing you can do for your customer until the source is found and repaired) is a portable radio.

Non intelligent, broadband noise sources have a number of characteristics which assist you in locating them. The most important of these is the frequency versus distance quality.

A broadband noise source is generated by a ramping voltage. The intensity of the discharge is greatest at lower frequencies, and diminishes in intensity as the frequency is increased. If you stood at a source with suitable test equipment (a receiver with a calibrated antenna and signal level readout device) you would find the device radiates EMI noise in inverse proportion to the frequency of the noise signal. If your calibrated receiver registered 100 units of EMI signal at 500 kHz (the bottom of the AM broadcast band), it might be 10 units of EMI at 10 MHz and 1 unit at 100 MHz.

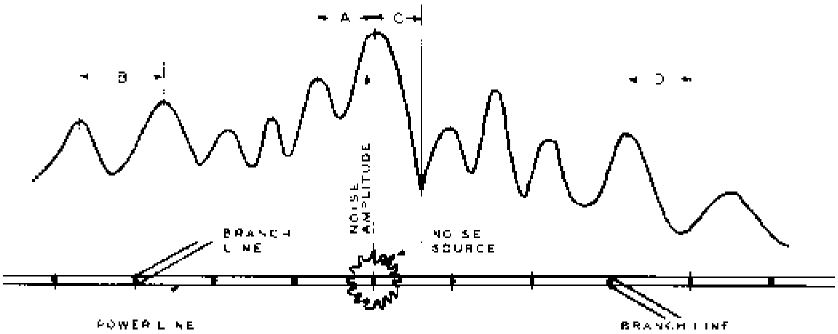
This is very useful knowledge.



Typical ferrite rod (Dick Smith R-5105)

Equipped with a portable radio (a signal level readout is not essential; your own internal hearing system used in conjunction with the receiver volume control is +/- 3 dB accurate), you begin by listening first to the level and then checking for the highest frequency at which the noise can be detected. With an AM/FM radio, tune to between stations where the noise alone is heard. On the AM band, your ears may detect noise better if you tune in a distant, barely audible AM signal. Weighing the distant signal against the noise, your mental computer will be best able to determine how, as you move about, the relative ratio between the EMI noise and the desired signal changes. Also, see page two here for a simple EMI signal level meter to be used with your portable radio/EMI tracing system.

On the AM broadcast band you are likely to hear many different EMI sources at the same time. If you happen to be using all band radio (equipped with AM, some portion of the shortwave frequency region and FM), the ability to check above AM broadcast but below FM will be very useful.



EMI STANDING WAVES (peaks, valleys) are caused by resonance, branch lines, pole line hardware, stays. Distance between peaks and valleys shortens (compare A and C to B and D) closer to actual EMI source.

Additionally, the AM broadcast band built-in loop antenna has directional characteristics (a null at the ends of the ferrite rod antenna) and by rotating the radio/antenna you can determine with the null where the signal is not coming from.

Now the ramping part. The closer you move to the source, the louder it becomes in the AM broadcast band. At some point, typically within a kilometre or so, you are so close that additional increases in EMI level are impossible to accurately gauge. That's when you switch either to a shortwave frequency or the FM band. As soon as you are within a few hundred metres of the actual source, you should begin to hear the EMI inside of the FM broadcast band.

Whether you are using a portable radio, or using your in-car/truck AM/FM radio as a tracking device, you will notice that as you cruise along beneath the power lines there are peaks and nulls in the EMI signal. These occur with regularity and should not be confused with having passed the actual source of the EMI. If you are still moving towards the source, a null (drop) in signal will shortly be followed by another peak (and then another null, etc.) with each successive peak getting slightly stronger in amplitude. The nulls and peaks may also be convoluted by the passing power poles and secondary transformers; they act like tuning (or detuning) elements to the EMI wave being transported by the power lines and cause random variations in signal level especially in the AM broadcast band region.

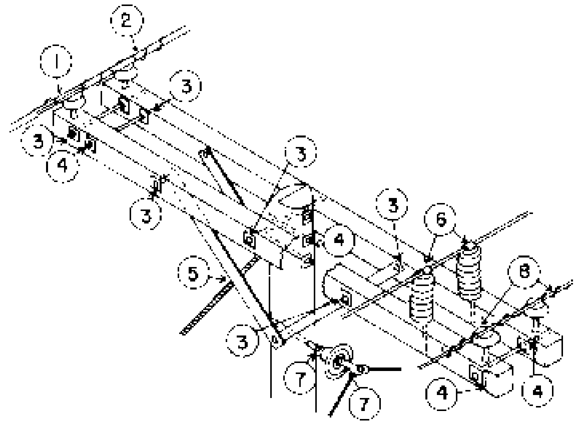
When you hear the signal within the FM band you are close to the source. You will verify the apparent source by driving/walking from where you first hear the EMI noise on FM until it peaks, and then continuing until it fades away on FM. Return to where it seems to peak and if you are not already on foot, do so now.

Survey what you see. Are you standing beneath a power pole? Are there service lines connected to the pole? As you follow the service lines to the building where they terminate, does the EMI level increase?

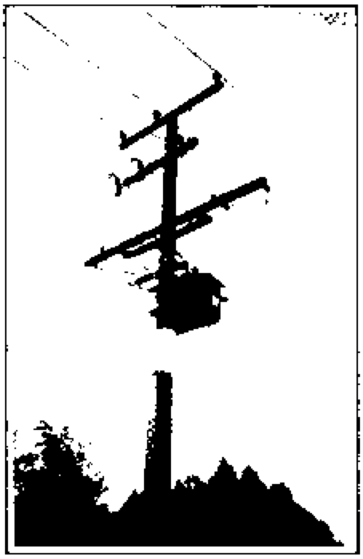
If the answer is yes, it does increase in level, the EMI source is probably connected to the AC service system of the building. If, on the other hand, the signal amplitude seems to stay constant or decrease as you move away from the pole, the source may be at the pole.

POWER LINES AS SOURCES

Unfortunately, the AC power distribution system is capable of being more than a



POLE line configurations vary greatly, within plant and between districts. *This is a sample only.* (1)(2)(8) insulated tie wires; (3) possible loose hardware; (4) sparking between non-associated hardware; (5) sparking stay wire to brace; (6) loose clamps atop insulators; (7) loss of clean metal-metal contact in pin and clevis of (bell shaped) insulators. For guidance only.



transmission conduit for external EMI sources. It can also be an EMI generator.

Corona discharge is the technical name given to power line oscillations. This is a fancy name for arcing.

An arc (spark) occurs when there is a high resistance between the power source (say an 11 kV line) and connection to a 'grounded /floating' metallic object near to the power line. The resistance is seldom placed there on purpose by the power line company; it is the result of aging of the line. Therefore it can be repaired, when found, by removing the high resistance 'bridge'.

The most perfect insulation material known is a vacuum. Dry air is a reasonable second on the list, followed by wet air and then everything else. A concrete pole is a better insulator than a wet (aged) wooden pole.

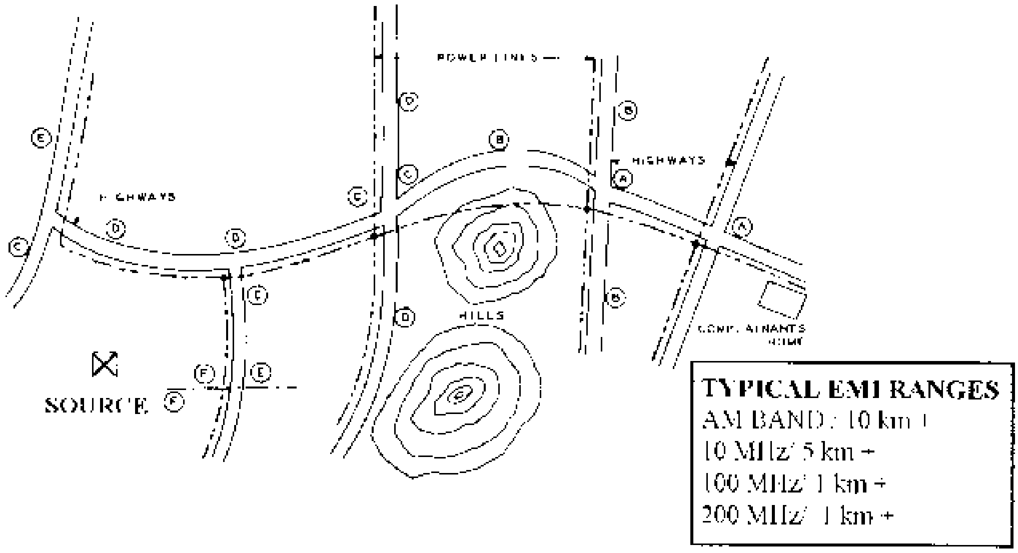
When a metallic portion of an electrical distribution line ages, its' (often galvanized) surface oxidises. This oxide (rust) is a higher resistance to the flow of electricity than the original pristine part. Power lines utilise many galvanized bolts, nuts and washers. They also utilise special staples, customised double helix spring washers, hair pin washers and metallic-ceramic insulators. Any metal part will deteriorate with age and if it is installed in an area with high salt-air contaminants, or chemical contaminants from factory exhausts, the rate of aging is accelerated. The aging process increases the surface resistance of the part. And just like the wearing that occurs with the imperfect wiper of a household electric light dimmer switch, this aging causes arcing. We already understand that arcing is another word for EMI generation.

In addition to aging, power lines are subject to tremendous mechanical stresses. A 100 metre run from pole to pole of wire the size of your thumb has considerable wind resistance. In time the mechanical integrity of the power wire to pole connection deteriorates. Nuts loosen, bolt heads slip, washers twist and loosen. When this happens, the system becomes 'loose' and subject to vibratory motion. Connections that began life tight loosen and when loose they no longer form a proper surface to surface bond. This loose bond has a higher resistance to the flow or carriage of electricity than the original tight bond. And .... arcing occurs.

Noise created by corona discharge within a power line is not unlike noise generated by a defective set of brushes in a refrigerator motor or fish tank heater thermostat. If you are listening to both on a portable radio, only with experience can you be expected to detect the slight differences.

The corona discharge has a timing element which can be measured with suitable (scope display) test equipment. For the record, the spark current rises from zero to a peak in about 1 nanosecond (nS) and then dissipates (discharges) in the 2nd nanosecond. This is followed by repetitive lower amplitude recycling of the discharge current for approximately 4 additional nanoseconds. The typical recharge time between the end of the first (major) discharge peak and start of the next major discharge is on the order of 200,000 nanoseconds (a nanosecond is one thousand-millionth of a second). As a practical matter, the EMI 'buzz' sounds pretty constant to the ear although it is possible to detect buzz-buzz-buzz cycling with ear practice.

Power line generated EMI tends to have a maximum amplitude at several frequencies between 100 kilohertz and its upper limit (past 200 megahertz). Some of these amplitude peaks may elevate the amplitude by as much as 30 dB at frequencies near 600 kHz, 1.4 MHz, 3 MHz, 4.8 MHz and so on up into the spectrum. If you are equipped with a suitable AM and shortwave and FM receiver, you can tune (preferably with the receiver in the AM detector mode) through a wide spectrum region and note for yourself how power line generated EMI has these peaks and valleys in amplitude. However, as you move upward in frequency, the average EMI level will decrease and the peaks will be successively lower in amplitude.



TYPICAL EMI RANGES
AM BAND : 10 km +
10 MHz/ 5 km +
100 MHz/ 1 km +
200 MHz/ 1 km +

TUNE to highest frequency on which EMI can be detected; (A) AM band; (C) 10 MHz; (E) 100 MHz; (F) 200 MHz.

One of the most pronounced peaks in the VHF region occurs within TV channel 1. Power line EMI appears as broken, erratic 'shot lines' on the TV screen and depending upon the proximity of the TV set to the source, can degrade or ruin TV reception even when the TV signal level is near 0 dBmV (60 dBuV).

Power line generated EMI caused by oxidised pole parts will usually be worst when the air is dry and dust has coated the parts. If the power line noise seems to abate after a good rain, suspect oxidised parts at a pole (or poles). On the other hand, power line EMI caused by loose parts tends to be worst when there is wind since the parts move more at that time. A single pole may have both oxidised parts and loose parts so you may have two EMI sources at a single pole. Remember that once the EMI is generated, the power lines become a conductor (transmission line) and a radiator (antenna) for the noise and one bad pole can affect an entire region of a town.

FIXING POWER LINE PROBLEMS

Most power suppliers are aware that their plants can create undesirable EMI. Some power suppliers have personnel assigned to this task; some, not many.

The first rule is do not attempt to fix a power line problem on your own. You have no business on power poles. And contrary to popular folklore, beating the base of a pole with a heavy hammer (or ramming it with a truck) is not an acceptable 'repair' tactic.

Oxidised parts won't change their discharge rate when beat upon. Poles with loose hardware, on the other hand, may well break into EMI-oscillation when gently tapped with a medium sized hammer. There is a world of difference between gently tapping and robustly beating a pole. Gently tapping, as a method of verifying a particular pole is at fault, may be permissible; beating is not. Shaking a pole stay (guy wire) may also be acceptable but you might check with the power utility first.

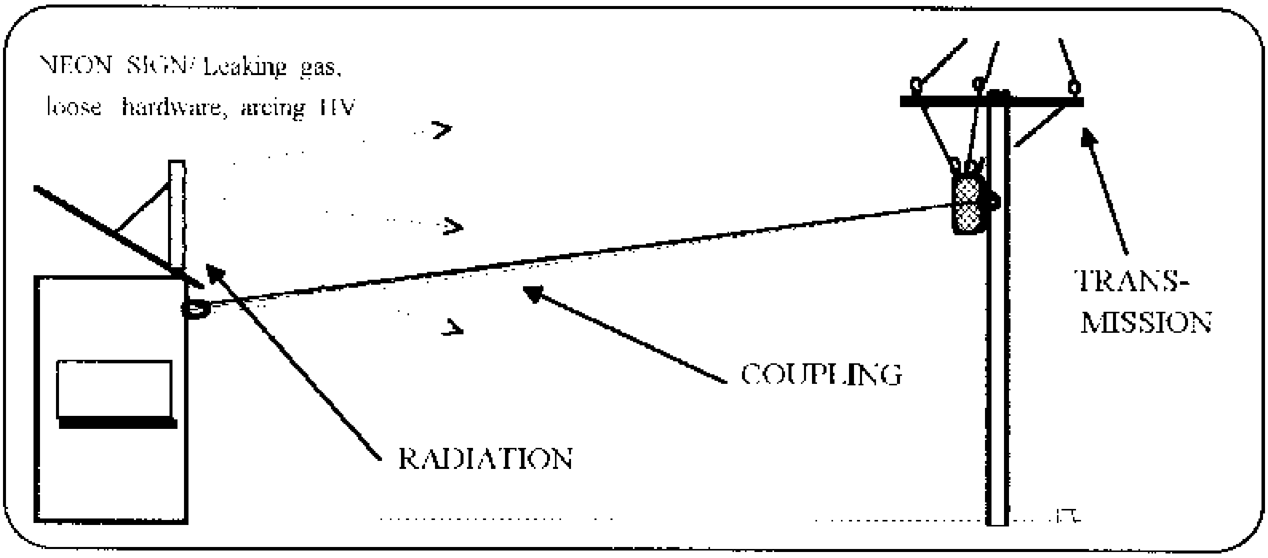
Calling the power people to report "*You have a noisy pole in Dargaville.*" seldom gets you assistance.

" *A pole opposite 65 Victoria Street in Dargaville has loose hardware and is generating radio and television interference,*" on the other hand, may get a response. The more information you can provide, based upon your own investigation, the better your chances of assistance. Power suppliers are seldom equipped to locate interference: even to verify a report of EMI. If you can lead them to the pole (or poles) your chances of repair improve dramatically. If you can stay there with your monitoring equipment to verify the problem has been found, your chances of a real fix improve measurably. ROG (RFS) reports power suppliers seem genuinely dedicated to repairing noise leaks but caution "*You may have to stay on them to get service; it is important you show them precisely where the problem is, even down to suggesting the* particular *hardware at fault*".

Now let's return to the building we were standing outside of several pages ago; we'd tracked the EMI down the street to a specific pole where it peaked in the FM band, and from there we followed a power 'drop' connecting to a building. In our example, the building is commercial and up there on the roof the EMI investigator spots a neon sign.

Neon signs are gas discharge tubes filled with neon gas. High voltage operates the sign and neon signs are legendary in the EMI business. First of all, they are often poorly designed. Unless the pressurization system is perfect, minute amounts of neon (and other trace elements) leak out. This causes the sign to flicker and if you study the flickering while listening to your EMI noise you will notice that as the flickers pulsate the noise pulses as well. This is a major source of EMI; a loss of gas pressure. Another source is the poorly installed electrical connections (loose, oxidised connections) which are profusely with the high voltage applied. Neon signs can be filtered (filter on the supply line to keep the EMI from feeding back into the power grid) but the sign itself will continue to radiate until its connections are cleaned up and the gas pressure restored. Not all neon sign owners are cooperative.

EMI coming from inside a private home or business presents a potential social problem. If anyone in the building uses TV or radio, or perhaps has a stereo, they are experiencing the same problem; perhaps severely. The first approach is to ask if they have any interference, suggesting you may be able to help them find the cause. If that fails to gain their confidence (and an invitation to come in for a look around), you might have to suggest that whatever is causing the interference (which you believe is coming from their area; perhaps their building) is creating problems for others.. As a 'good citizen' they should be interested in solving the problem, even if they either do not



care about their own impaired reception, or are somehow not experiencing problems.

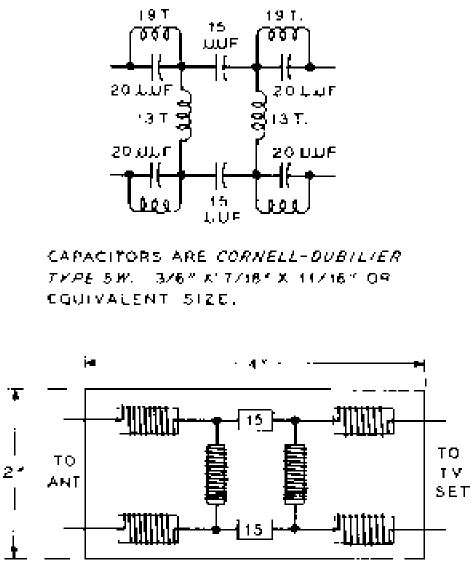
GETTING IN CLOSE

If interference is raising havoc inside a building, an entire premises EMI search may be necessary. From the lists of potential EMI sources here, you are aware that almost anything that hums, flickers, radiates or goes bump in the night can be the culprit. If the problem is confined to radio and TV reception, the portable radio used for EMI tracking is put to work as a signal-sniffer. Because you are close to the source, you will be on the FM band. If the set has a telescopic rod antenna, you may need to collapse the rod entirely to prevent receiver overload from the close proximity EMI source. If the entire building seems 'hot', and you cannot desensitize the portable radio enough, try removing the telescopic whip entirely. You could also bring in a battery operated small portable TV, tune it to band III (channels 4-11) in between stations and use its' rod telescopic antenna as a signal sensor. Within a few metres radius a really strong EMI source will show characteristic horizontal lines on the screen even on band III.

Your sleuthing may take you to a wall outlet where nothing is plugged in. That means this particular circuit is 'hot' with EMI and you need to check other outlets on the same circuit.

By disabling one circuit at a time, one appliance at a time, you will narrow down the search to a single outlet and a single appliance. Remember that not all appliances are obvious; a tiny aquarium or fish tank heater may not even be recalled as being present. Likewise, a mattress cover electric heating pad, an appliance that "*...hasn't worked for months...*" but still left plugged in. If you are certain the EMI source is nearby, you will find it even if it is not an obvious source.

Don't overlook lightning fixtures. Some very old style 25 watt incandescent light bulbs, and some brand new bulbs have the mysterious ability to generate very ragged bands of EMI in the 50-70 MHz region; TV channels 1-3.



CAPACITORS ARE *CORNELL-DUBILIER TYPE 5W.* 3/6" X 7/16" X 11/16" OR EQUIVALENT SIZE.

WIND 19 TURN COIL ON EACH END CAPACITOR.
WIND 13 TURN COIL ON 10-MEGOHM RESISTOR, 1/4" DIAMETER.

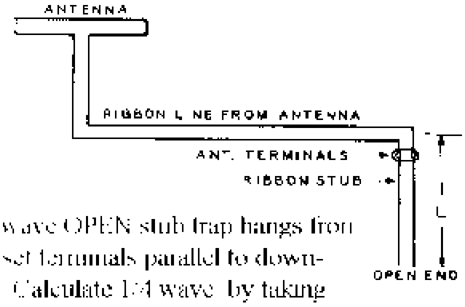
DO IT YOURSELF TVI FILTER- this high pass filter can be shop built with parts probably on hand. Filter is for 300 ohm balanced lines; add balun at both ends for 75 ohms. Enclose in suitable case for tuning stability; preferably NOT metallic.

Fluorescent lamps are, like their design cousins the neon signs, notorious creators of EMI. The mercury vapour is activated by a stream of electrons and this stream of electrons through the lamp ballast system turns on and off at twice the AC line rate; i.e., 100 cycles per second. The cyclic nature of the electron beam is a near perfect environment for the creation of harmonic energy; at 200 hertz, 400 hertz, 800 hertz and so on right up through the medium VHF range. The good news is that individual fluorescent tubes seldom 'transmit' over much range and most of the EMI energy is concentrated below 5 MHz.

INTERMITTENT EMI

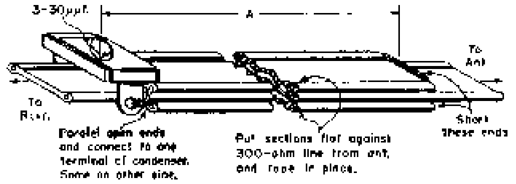
Most forms of EMI are not constant; they either operate on some sort of schedule (the neon sign that turns on at dusk, off at sunrise),

IT'S CHEAP - TRY IT!



1/4 wave OPEN stub trap hangs from TV set terminals parallel to downline. Calculate 1/4 wave by taking 300 and dividing by frequency in MHz. Divide that by 4 and make stub extra 10mm longer. Trim stub by 2mm chunks until TVI is at minimum

ICE Model 432 75 ohm set-back filter


3-30μμf.
A
To Ant
To Rcvr.
Parallel open ends and connect to one terminal of condenser. Same on other side.
Put sections flat against 300-ohm line from ant. and tape in place.
Short these ends

Tunable trap; two lengths 300 ohm flat line taped either side of downline, tuned with 3-30 mica trimmer. 'A' length .17 wave at offending frequency.

or seemingly by the clock ("*Every night at 6:30 I lose* **Paul Holmes** *and the screen fills up with snow with a whine in the sound...*"). The time EMI starts and stops is a clue; use your logic. What turns on at dusk and off at sunrise? Something designed to operate in the dark.

What starts every night at 6:30 PM and lasts for five to ten minutes? Somebody going to their kitchen to prepare something to eat. Possibly a food blender, a table top oven, or a coffee jug.

What comes on for a few minutes, goes off for a period, and then repeats the cycle? A thermostat controlled device.

What only acts up when the wind is blowing? Something outside; perhaps a power line connection, or an electric fence with shoddy hardware and/or loose connections. Electric fences 'earthed' are particularly noisy and if they run along parallel to overhead utility lines, the EMI may inductively couple into the overhead lines. The lines can carry the EMI miles (transmission line effect) and drop it off (radiating; the antenna effect) along the way.

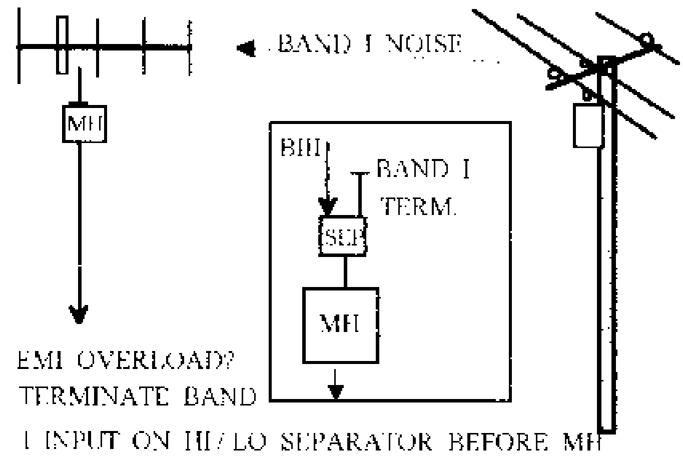
UNSUSPECTING USERS

Although any device which radiates RF energy is supposed to have Ministry of Commerce approval (which involves testing) before being sold, there are always a few that slip past this step. Cordless telephones are a special problem. Those approved for New Zealand sale occupy transmit ranges around 34 and 40 MHz. Unfortunately, travelers to spots such as Singapore and Hong Kong or the USA see bargains they cannot refuse bringing back to New Zealand cordless phones which operate in the 45-47-49 MHz region; or higher. A 100 milliwatt 47 MHz cordless phone is capable is wiping out television reception for several km, especially in a fringe area for channel 1.

Another cordless wonder, the Baby Minder, is sold as a wireless intercom. The sender is left at the baby's crib and the receiver is typically placed elsewhere in the house; such as in the parent's bedroom. Baby Minders create up to 100 milliwatts of RF in the 49-50 MHz region and unlike the cordless telephones, they operate typically 24 hours each day. Again, a TV channel 1 problem (as if channel 1 didn't have enough problems without all of this outside help!).

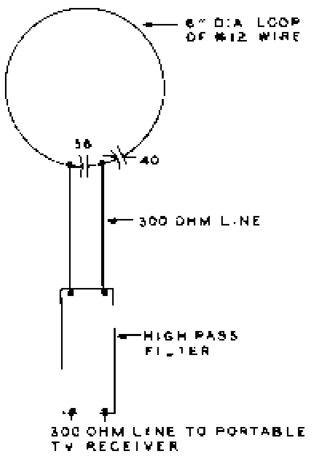
RATIO / INTERFERENCE TO DESIRED

Those who have studied TB9302 and 9303 realise without being reminded that when the off-air TV signal is weak to begin with, the ratio of TV signal to noise (whether manmade interference or atmospheric) is marginal. This



EMI OVERLOAD? TERMINATE BAND I INPUT ON HI / LO SEPARATOR BEFORE MH

TUNED TV pickup loop allows in-close EMI 'sniffing' with portable TV. Mount on wooden dowel. 56 pfd is silver mica.. For high-pass see page 15.



makes fringe area reception even more prone to interference from the family of sources cited here.

A masthead amplifier, often employed to boost the weak TV signals, can make the TV reception even worse when there is a strong (local) noise source. Most mastheads are broadband in design, even if you are using only a portion of its bandwidth (such as band III only because all of your TV signals are there). A strong interference source centred in the 60 MHz region can easily overload a masthead causing cross modulation; the amplified noise at 60 MHz transfers to the already weak band III TV signals causing significant new degradation of the band III signals. A VHF-UHF (bands I,III,IV and V) single antenna input masthead used for UHF only can accept VHF noise which will cause overloaded noise plus signal conditions in the UHF band. One solution to both of these problems is to install a band separator at the input to the masthead, terminating the VHF side of the band splitter so that only the UHF range signals are actually processed through the masthead (or, a band I, band III separator, terminating the band I input).

THE PASSIVE MIXERS

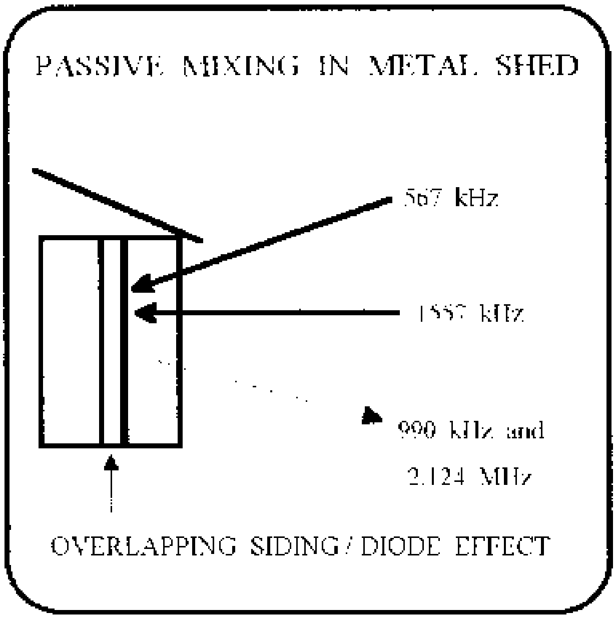
The most basic RF detector consists of a diode; two pieces of conducting material in a sandwich. A metal sided/roofed barn or shed provides all of the necessary ingredients. So too will a metal water pipe and a second (perhaps gas or other purpose) pipe touching one another.

Two pieces of metal, touching under the wrong circumstances, create a non-linear rectifier device. When the point of contact between the two metallic surfaces is excited by two or more relatively strong radio wave signals, the signals are rectified and mixed; just as a purposeful mixer in a receiver creates a brand new receiver frequency (i.e., the receiver i.f.).

Say the non-linear connection is excited by a strong radio field at 1557 kHz and another signal at 567 kHz. The non-linear point mixes the two together by adding 567 to 1557 and that produces a new signal at 2.124 MHz. At the same time 567 is subtracted from 1557 and this produces a new signal at 990 kHz.

2.124 MHz and 990 kHz will now radiate from the metal of the barn and anyone tuning a receiver to either of these two frequencies will be surprised to find the modulation originally appearing on 567 and 1557 mixed together on the new frequency(ies). The entire system is totally passive; not a mA of electricity is consumed.

The solution is to break the 'point contact' between the two surfaces; either bond the metal parts together hard (destroying the loose point


PASSIVE MIXING IN METAL SHED
567 kHz
1557 kHz
990 kHz and
2.124 MHz
OVERLAPPING SIDING / DIODE EFFECT

contact which in turn creates the diode effect), or insulate the two from one another.

Carried to VHF, a strong 224.25 (channel 11 video) mixing with a strong 175.25 (channel 4 video) produces a difference frequency (224.25 - 175.25) of 49.0 MHz. This falls into TV channel 1 and on a TV set the mixed products would appear as both channel 4 and 11 video together, showing up on channel 1.

THE ROLE OF ROG

Once upon a time (as all good fairy tales begin) the Radio Frequency Service (RFS; now Radio Operations Group or ROG) was actively involved in matters of interference. In June 1991, the RFS released a slick, glossy publication intended to advise viewers and radio listeners of their rights to interference free reception.

1/ PIB June 1992; Ministry of Commerce

Television & Radio Interference (*Your Guide To Better Reception*) (1) is still available through ROG offices (see Tech Bulletin 9301 for a listing of ROG offices). The booklet is free.

Patterned after an earlier (1990) Australian DTC publication (**Better Television and Radio Reception**), the Kiwi version shows examples of television interference and explains in lay terms what causes the interference. Unfortunately, there is little information about curing the problems detailed.

Can you call in ROG to assist you? Yes and no. The publication advises viewers/radio listeners to first contact their service personnel and try an external to the TV set filter. The viewer is given little expectation for many forms of interference, and RFS wrote:

"*Radio, electrical and electronic products can cause radio interference .... the last decade has seen unprecedented growth ...* (and) *... the result is increasing levels of* (radio) *interference.... this trend is likely to continue indefinitely.*"

RFS also wrote:

"*The Commission* (here referring to the Broadcasting Commission) *does* NOT *provide funds for the control of harmful interference.*"

And, "*The New Zealand Radio Frequency Service has a trained, experienced and well equipped field staff to investigate complaints of television and radio interference, and will endeavour to trace the source and ensure compliance ... the costs for this work are borne directly by broadcasters through license fees payable to the Ministry of Commerce. However, if it is found that the problem is due to a faulty or substandard radio or television receiver (including the aerial system, video unit or other attachments), a charge will be made.*"

Under the older Post Office Regime, a person with faulted television or radio reception could ask for a radio inspector field visit. Under the newer 'user pays' programme, RFS/ROG analysed where the manpower-hours were going and found as many as half the total work hours were spent helping people correct interference faults. Further study revealed perhaps 70% of these faults were not faults at all; the TV viewer had a broken aerial, the lead-in wire was rotted and so on.

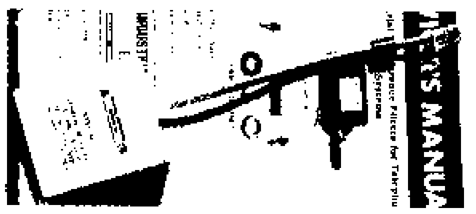
ROG now responds to requests for 'service calls' by sending out a form (Radio 7) which the complainant must complete, sign and return. The form tells people that if the problem is found to be a faulty TV, VCR, aerial or other premises reception equipment, a minimum charge of $54 will be made. Requests for field visits have dropped by two-thirds since this programme began.

Now, if the reception problem is found to be a faulty neon sign or thermostat, what is the next step? Suppose the neon sign owner refuses to repair his sign; is there authority to force him to shut it down until it is EMI-clean?

And the TV serviceman who was called in; is his role replaced by the ROG field person? If the problem is found to be audio rectification, and the 'fix' consists of placing a pair of disc ceramic capacitors across the AC mains line, will ROG do this work or merely advise?

We took these questions to ROG.

A genuine problem, occurring inside of a recognised TV transmitter service area, creates no user pays fees. The neon sign owner would be contacted and advised of the problem. There are laws on the books which allow the inspector to demand the neon sign be shut down until repaired, if it comes to that. ROG advises "*This is rare; most interference affects people in an area surrounding the source. They are neighbors. Few can stand the social pressures of being a TV or radio interrupter and only rarely does the remedy involve an order to shut some piece of equipment down*".



ICE MODEL 405 TELCO FILTER

We found ROG personnel are very well versed on audio rectification problems; some offices suggest ten percent of their field problems involve this fault. ROG personnel typically believe the receiving appliance (or stereo set) is poorly designed and without hesitation advise the complainant they should contact a serviceman for modifications.

At the moment ROG is experiencing coordination problems with Telecom. When Telecom was state owned, they routinely supplied RF suppressed telephones for customers who experienced telephone pickup of strong RF signals. Now, as often as not, telephone interference cases end up going round robin; the ROG inspector sends the customer to Telecom who returns the favour by sending the customer back to ROG. The telephone user, meanwhile, continues to have interference. Even cordless telephones have recently been the source in audio rectification reports involving stereos, seemingly proof that as life becomes more electronic the pollution of the airwaves expands at a logarithmic rate. ROG sources suggest the telephone audio rectification problem is primarily one of responsibility; to date there has been no evidence that anyone is willing to assume responsibility. ROG believes, however, that the fault is almost never with the transmitter operator since telephones, like stereo sets, have not even the most modest precautions against RFI ingress.

The posture of ROG has changed as the home communications industry has changed. The days when Frigidaire refrigerator butter keepers were number one on the TVI culprit list are long past and few in the Ministry of Commerce would wish them back.

IN SUMMARY

While simplistic add-on filters may cure a percentage of the EMI problems, they are seldom an adequate solution to problems relating to broadband noise sources. And the responsibility to repair such sources may not be clearly defined under existing regulations.

Your customer might wish he could make a single phone call to a government agency based upon the assumption that payment of the annual Broadcasting Fee 'guarantees' perfect reception; in truth your customer is at the mercy of the EMI environment in his area. His air and water may be pure, his country may be nuclear free but his radio spectrum is polluted. And with every additional cordless phone, two-way radio and electrical applicance brought into his neighborhood, the pollution of the airwaves will grow worse.

A radio and TV serviceman who recognises this trend can perform a useful service and increase his own revenues by adopting a professional approach to interference. It's 1993; wake up and listen to the noise.

EMI CORRECTIVE PARTS AND REFERENCES

Telephone/Radio Interference Filters:

The ICE (Industrial Communication Engineers, Ltd.; U.S. made) line of telephone, television, FM radio reception filters as well as their line of ham radio transmitter (harmonic) filters are available exclusively in New Zealand from **K.M. Tronics**, PO Box 3208, New Plymouth (06-758-4359). Coop rates these filters of high quality and pricing is reasonable.

Dick Smith Electronics carries a pair of ham radio harmonic filters (D7080 rated at -50 dB surpression at 100 MHz; D7082 rated at -80 dB supression at 40 MHz) and a single TV set high pass filter (D7084 rated at -20 dB for 27 MHz /CB signals).

Lincrad Aerials Limited (17 Washbournes Road, Sockburn. Christchurch 4; 03-348 0659) carries the Kingray FLOFM (a masthead FM filter to remove 88-108 MHz FM from a TV system), plus stop band filters for 120-160 MHz (FLBSP 120-160 MHz) and 44-160 MHz.

Signal Master (PO Box 12-373, Penrose, Auckland; 09-525-5599) carries a low cost 88-108 MHz FM band filter for TV reception systems.

Kingray offers the afore mentioned FM filters and FLBSO which is a 0-52 MHz filter (which will chop out channel 1) with -30 dB attenuation.

Telephones: **Telecom Rentel** (model) **410** is current RFI-'proofed' phone; ask for it by number.

Parts For Filters:

Derek Fortune Audio (PO Box 82-272, Highland Park, Auckland; 09-537-6370) has perhaps most complete New Zealand stock of "Micrometal" core/torroid forms. These are essential in RFI supression to audio devices (stereo, telephones) and are also effective with computer caused EMI and radio-TV interference. Ferrite rods, beads, cores are in stock and Derek knows his product line well; you describe the problem, he will respond with the proper part and instructions on how to use it to eliminate the EMI. Most are very reasonably priced and Telecom and others routinely use these parts.

Reference Materials:

INTERFERENCE HANDBOOK (William Orr) available for $18.60 inclusive from NZART Publications, PO Box 40-525, Upper Hutt 6415 is without question the most helpful book (200+ pages) dealing with EMI causes and solutions.

COMBINING CROSS POLE SIGNALS

WITHOUT A COMBINER

From a concept suggested by
Mike Fouhy of BCL

On the Kapiti Coast north of Wellington viewers can receive TV1 and TV2 from Paekakariki on channels 6 and 8 **vertical**. TV3 presently comes from the Kaukau site in Wellington on channel 11 (late in 1993 on UHF from Waikanae); **horizontal**. From the Kapiti Coast area both transmitter sites are in the same approximate line.

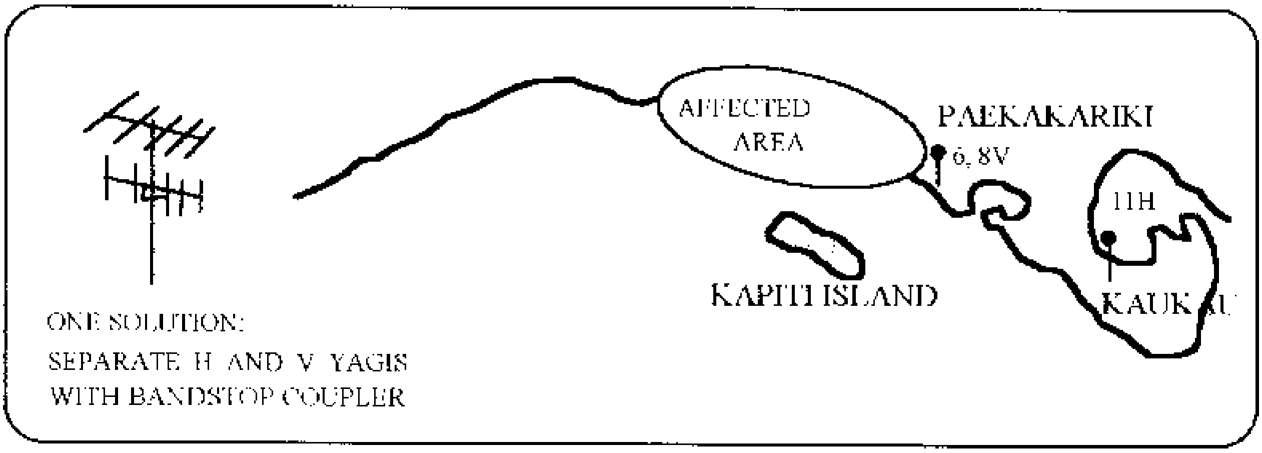
If the viewer utilizes a slanted (45 degree) yagi to receive the two vertical + the one horizontal signal, antenna polarisation is not 'pure' for either transmitter site. The slanted yagi is a sitting duck for weather enhanced tropospheric co-channel and can contribute materially to enhanced ghosting problems. Additionally, by being 45 degree 'slanted' the antenna gives away 3 dB of signal for both polarisations.

One installer answer has been to use a pair of yagis - one horizontal and one vertical - together with a suitable bandstop coupler which ensures the antennas do not feed co-channel or ghosting signals into the opposite polarisation's downlead signal. This solution also offers 3 dB more signal level than a 'slanted' yagi since each yagi is 'true' with its source signal(s).

The negative side of this solution is cost. While the two yagis might cost (only) $50 each, a weatherproof bandstop coupler that passes 6 and 8 through one port and 11 through the other can be $70 or more. Such couplers exist because of unique to Wellington/Nelson reception problems where 9 and 11 must be separated. Creating an effective bandstop coupler that will pass one channel and reject another, only two band III channels apart, requires considerable skill. Making the coupler more or less impervious to weather and climate changes adds to the cost.

ANOTHER SOLUTION

What follows is a 'paper solution' which to date has not been appropriately tried in the



ONE SOLUTION:
SEPARATE H AND V YAGIS
WITH BANDSTOP COUPLER

field. However careful analysis suggests it would work and in the process reduce installer costs while simultaneously improving the customer's picture. Here's the theory.

Two identical yagi antennas are mounted such that each slants 45 degrees, but in opposite directions. Ideally, the yagis will be mounted on a horizontal cross arm so that each receives the respective signals from the same 'wavefront layer'. Mounting them on a vertical mast, one above the other, introduces new wavefront variables which might in some receiving situations compound multi-path problems.

The feed point (balun) for each yagi faces the same direction (i.e., **both** in, **both** out but *not* one in each direction). In our channels 6/8 and 11 example, the two yagi antennas are spaced 1.3m or more (not less) apart physically and are combined with a piece of coaxial cable. The pure way to join the two antennas is with a signal combiner but if you elect to merely 'Tee' the connection, as shown here, the penalty due to mis-match will be under 1 dB (in overall system gain) and as we shall see, 'Teeing' may offer mechanical advantages. Note the coaxial phasing line runs from one antenna to the other and then down to the customer's TV set in the normal manner; not from each antenna to a shared-combiner in the middle of the array.

So what's the secret here? The coaxial cable!

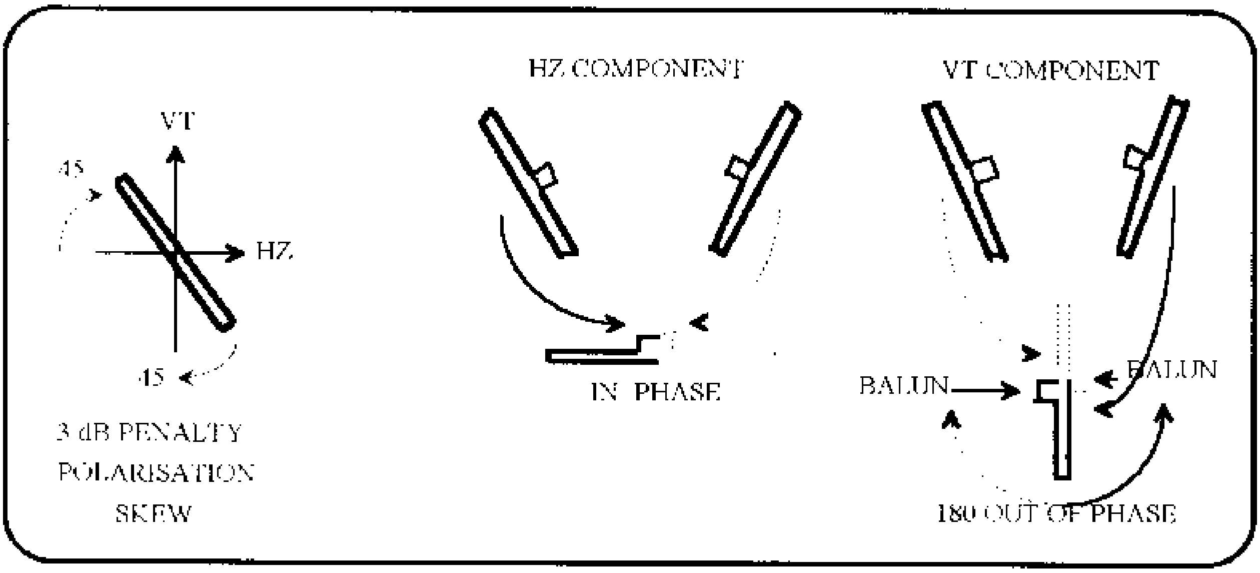
MORE THEORY

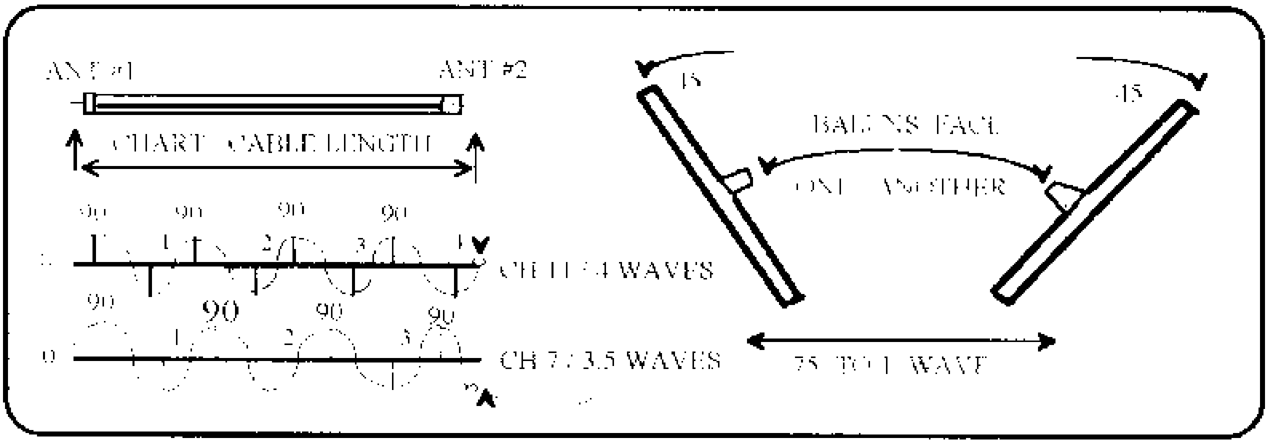
This antenna configuration has the ability to receive channel 11 with pure horizontal polarisation while at the same time receiving channels 6 and 8 with pure vertical polarisation. Why?

From the point of view of the horizontal signal, the two yagis are in phase with one another. The horizontal component of each yagi 'points up' if you define 'up' as being that side of the yagi on which the balun is mounted. If the baluns are facing at one another, the horizontal components are both 'up' as shown below.

Since the horizontal components will be in phase with one another, to combine the two antennas you need a piece of cable between them which is a whole number of wavelengths long.

Now for the vertical. From the point of view of the approaching vertical wavefront the antennas are out of phase with one another; one of the baluns points left and the other points right. Therefore to bring the vertical components captured by each individual antenna together 'in phase' we must combine the two antennas with a whole number of half wavelengths in connecting cable. The half or odd wavelength of cable causes the signal to be 180 degrees out of phase (a half wavefront cycle) with itself. Because the two antennas already create a 180 degree wavefront mis-match, we





have the signals out of phase as they leave each antenna. By introducing an odd-multiple or half wavelength of cable between the two antennas, we now restore the correct phasing for the vertical polarised signal: +180 added to -180 equals 0 phase angle difference. How do we select a single length of cable that will do both of these magic tricks?

THE COMBINING CABLE

Our arriving-at-the-antenna-in-phase signal is horizontal 11 in our example. Our not in phase signals are channels 6 and 8 vertical

Channel 11's video carrier frequency (VCF) is 224.25 MHz. Channel 6 is 189.25 while channel 8 is 203.25. Logic suggests that a compromise for the wavelength difference between channel 6 (300 divided by 186.25 1.585 metres) and channel 8 (1.476m) will be found at channel 7's VCF; 1.529m.

What you are looking for is a cable length which is an even number of full wavelengths long at 224.25 MHz and an odd (halfwave) multiple of wavelengths long at channel 7 (our compromise between 6 and 8). While you think about this calculator exercise, here's a quick solution:

1) Take channel 11's VCF (224.25) and subtract channel 7's VCF (196.25). The answer is 28 MHz.

2) Now find the length of a full wavelength at 28 MHz (300 divided by 28); 10.714 metres. Divide that number by two (arriving at the length of a halfwave at 28 MHz); 5.357 metres.

Now the 'test': how many full wavelengths at channel 11 is represented by 5.357 metres.

1) Find a full wavelength at 224.25 MHz; 1.338 metres. Take 5.357 and divide by 1.338; the answer is 4.004 times. So we are within .004 of a metre of being exactly 4 full wavelengths in a 5.357 length.

2) Divide 5.357 by our channel 7 wavelength (1.529); the answer is 3.504. That means we are within .004 (again) of being exactly 3 and one half wavelengths at channel 7.

So here is a condition where a length of cable can be a multiple of a full wavelength at one frequency (channel 11) and a multiple of odd half wavelengths at another frequency (channel 7). The cable combines the respective polarisations while at the same time separating 6-8 from the 11 antenna, and 11 from the 6-8 antenna.

The physical length of the cable will be the propagation factor of the cable times the indicated length; in our example, 5.357 x .82 (the velocity of propagation factor for RG-6/U Foam 7 type cable). This turns out to be 4.393 metres of this particular cable for our example.

Why start from a half wavelength at 28 MHz; the difference frequency between the two carrier (sets)? As an extensive table here shows, this is one of five examples (out of 21 possible) where the 'magic cable' length also happens to be a half wave at the 'difference frequency'. Those things happen with surprising regularity in electronics. NOTE: *This table is calculated,*

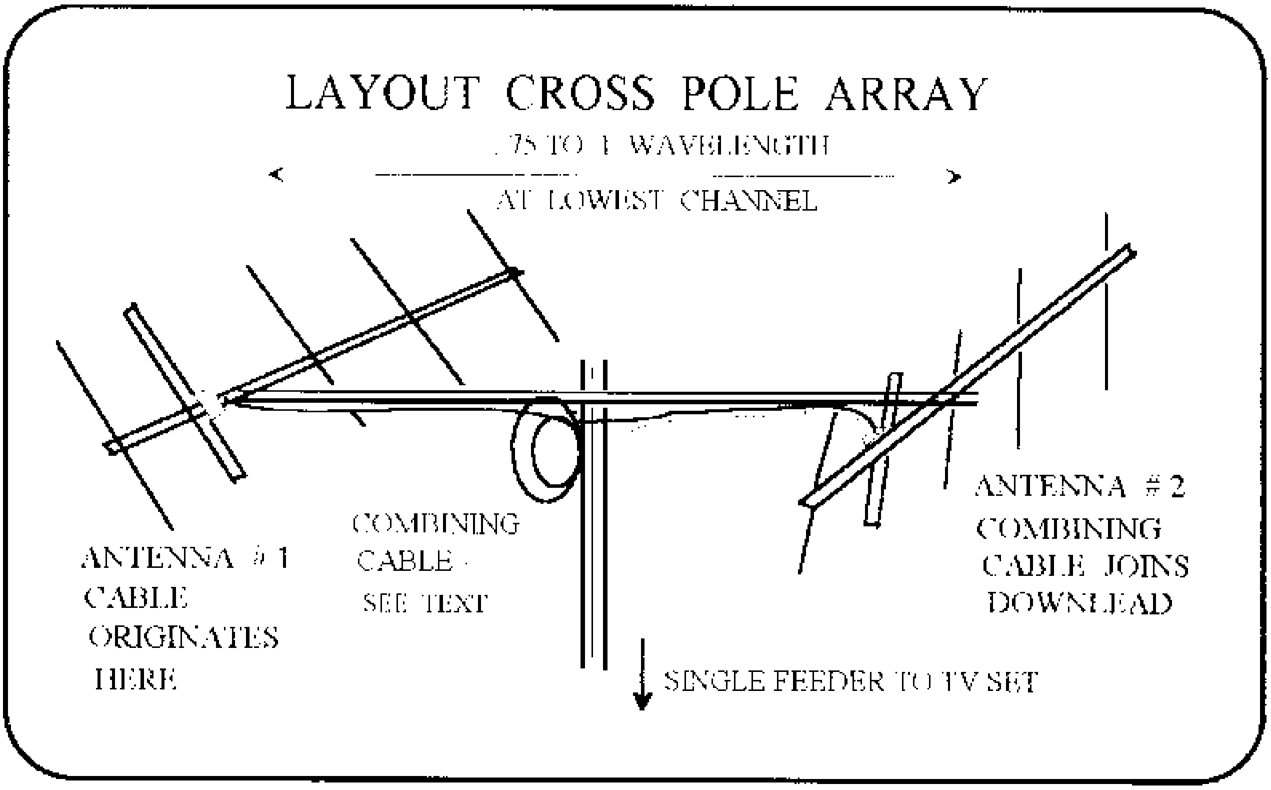
CHANNEL / POLARISATION COMBINING CABLE LENGTHS

Channel Group	Compromise Cable Length	Lower Ch.Match	Upper Ch.Match	Optimum Lower	Optimum Higher	Alternative Length (Low/High Match)
1 and 3	9.780m	1.475	2.029	9.945m	9.638m	
4 and 11	9.390m	5.485	7.018	9.416m	9.366m	
4 and 10	4.220m	2.465	3.056	4.280m	4.143m	11.085m (6.475 /8.027)
4 and 9	4.286m	2.504	3.003	4.280m	4.281m	(Note 1)
4 and 8	5.970m	3.487	4.045	5.992m	5.904m	16.250m (9.492/11.009)
4 and 7	6.100m	3.563	3.990	5.992m	6.116m	21.405m (12.503/13.999)
4 and 6	11.110m	6.490	7.009	11.128m	11.095m	
5 and 11	4.050m	2.461	3.027	4.115m	4.014m	25.460m (15.468/19.028)
5 and 10	4.130m	2.509	2.991	4.115m	4.143m	
5 and 9	5.730m	3.481	4.015	5.761m	5.708m	
5 and 8	7.390m	4.490	5.007	7.407m	7.380m	
5 and 7	10.715m	6.510	7.008	10.699m	10.703m	(Note 2)
6 and 11	3.990m	2.517	2.982	3.963m	4.014m	
6 and 10	5.540m	3.495	4.012	5.548m	5.524m	
6 and 9	7.143m	4.501	4.999	7.133m	7.135m	(Note 3)
6 and 8	32.485m	20.495	22.009	32.493m	32.472m	(Note 4)
7 and 11	**5.352m**	**3.500**	**4.000**			**(See Text)**
7 and 10	6.890m	4.506	4.989	6.881m	6.905m	
7 and 9	9.968m	6.519	6.985	9.939m	9.989m	
8 and 11	6.670m	4.519	4.985	6.642m	6.690m	
8 and 10	9.630m	6.524	6.973	9.594m	9.667m	
9 and 11	10.703m	7.500	7.999	10.703m	10.704m	(Note 5)

USING THIS CHART

Find the two channels you wish to combine (left hand column). Next column is length of cable to use before you correct for velocity of propagation (see text). Third-left column (Lower Ch Match) shows how close this length comes to optimized length; to be perfect, it will end with .500. Fourth column is higher channel match; perfect will end with .000. Fifth column is length for optimizing lower channel; sixth column for optimizing upper channel. Seventh column alternates are where other lengths will also do the same job (although with longer cable). These are NOT actual cable lengths; see text for correcting to velocity of propagation.

NOTE 1 - 4.286m is 1/2 wave at 35 MHz difference frequency. NOTE 2 - 10.715m is 1/2 wave at 14 MHz difference. NOTE 3 - 7.143 (close to 7.134) is 1/2 wave at 21 MHz difference. NOTE 4 - It is unlikely anyone will benefit from a 32.485m combining line. NOTE 5 - 10.715m (close to 10.703) is 1/2 wave at 14 MHz difference.



not field-proven and installers are invited to provide feedback!

THE CONNECTION

Most antenna combining schemes connect separate antennas together via a common 'middle ground'. Examples include parallel stacking bars (300 ohm antenna stacking) and coaxial combiners. In all cases, the bar/cable distance from each antenna to the 'common middle ground' is equal.

That is more by convenience than electronic reasoning. The antennas in this example are joined by cable (coaxial is shown; 300 ohm parallel line can also be used) but the 'common middle ground' is at the terminals of one antenna: not in the middle of the array.

1) The proper length of cable begins at the balun of antenna one and goes to the balun of the second antenna.

2) The cable will always be longer than the physical distance to be covered: excess cable is coiled (if 75 ohm) and taped to the horizontal boom or vertical mast. Do not allow this excess of cable to be within either of the antenna's physical areas.

3) At the feedpoint on the second antenna three connections come together:

a) Line from first antenna

b) Feedpoint on second antenna

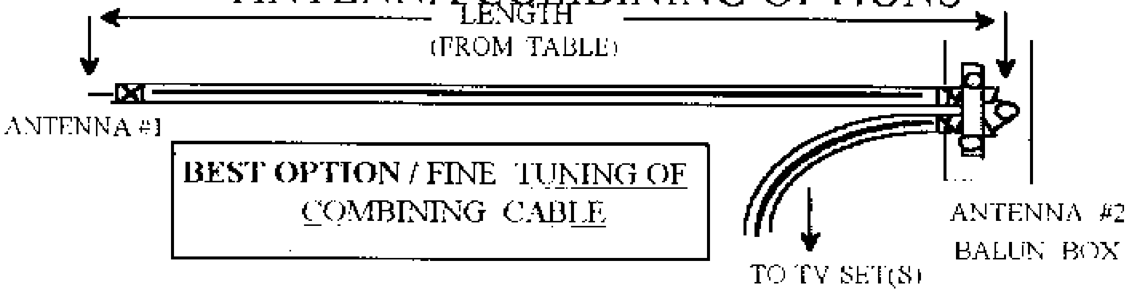
c) Downline to TV receiver(s)

Optionally, a 75 ohm 'T Connector' would join all three points together. Any connector introduces 'error length loss' at the 'Tee' and hard wiring to the #2 balun is suggested.

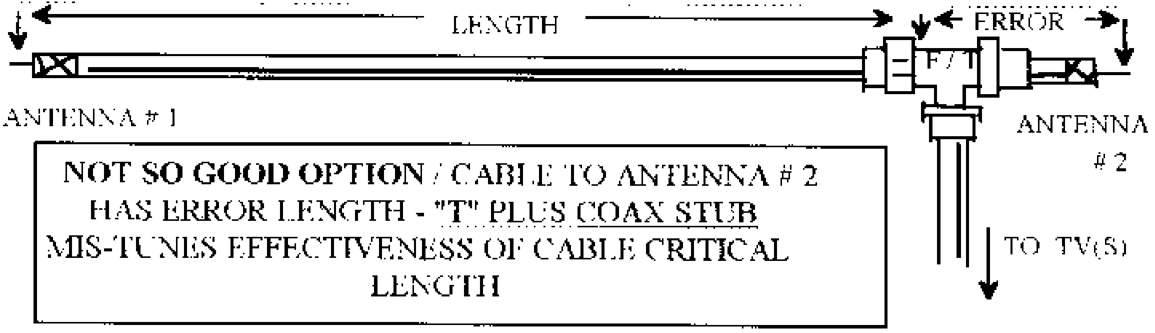
THE PERFORMANCE

'Teeing' the three cables together creates a mis-match and the system loss from this should be around 0.5 dB. In this example channel 7 is an admitted compromise between 6 and 8. If the cable is adjusted for optimization on channel 11 (4.0 wavelengths) channel 6/8 performance should end up being 0.7 dB less than optimization. At the same time, rejection of horizontal polarisation through the vertical 'side' is -8 dB rather than the ideal 'infinite'. Even given these conditions the performance on

ANTENNA COMBINING OPTIONS



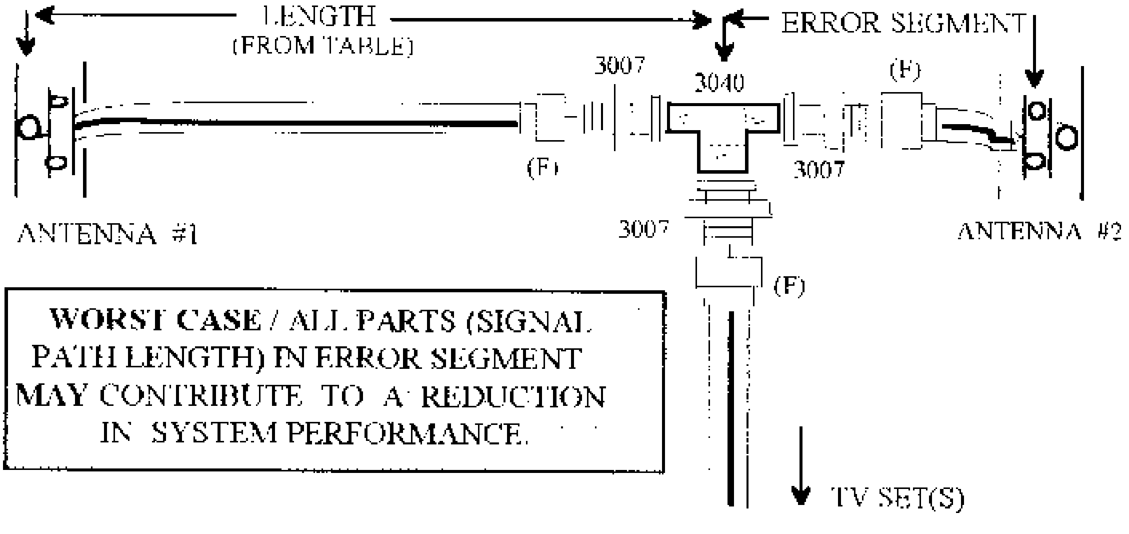
BEST OPTION / FINE TUNING OF COMBINING CABLE



NOT SO GOOD OPTION / CABLE TO ANTENNA # 2 HAS ERROR LENGTH - "T" PLUS COAX STUB MIS-TUNES EFFECTIVENESS OF CABLE CRITICAL LENGTH

channel 11 is much better than this (and 11 is the weaker of the two signals).

Coaxial link cable will have some loss (in the cable) reducing the amount of unwanted polarisation cancellation. My preference is to use (300 ohm) ribbon line because the losses are less. However, as an unshielded line it should not be (excess) coiled; it could be run

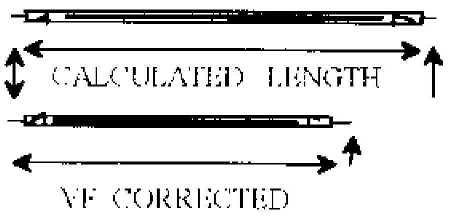


WORST CASE / ALL PARTS (SIGNAL PATH LENGTH) IN ERROR SEGMENT MAY CONTRIBUTE TO A REDUCTION IN SYSTEM PERFORMANCE.

PIECES / PARTS / ADAPTORS: Model '3TF' fitting (top of this page) available from Lincrad Aerials Limited, 17 Washbournes Rd., Sockburn, Christchurch.

ABOVE 3007 F/BNC adapters; 3040 BNC 'T' adapter available Lincrad and other suppliers.

VF CORRECTION



CABLE CORRECTION FACTOR

.66 / RG-59, RG-11
.75 / RG-6 ; **.79** / RG-59 Foam ; **.80** / RG-11 Foam, 300 ohm tubular; **.82** / 7 Foam, 300 ohm twin; **.95** / 1/2" spaced open wire.

(using standoffs) down the mast and back again. This would save a balun on one (the first) antenna as well.

If the antennas are mounted one above the other, you could experience unwanted polarisation skews. Side by side spacing maintains 'same transmission field' integrity for the antennas. How far apart? No less than 0.75 wavelength at the lower channel (1.2 metres at channel 6) and better if 1 wavelength (1.6 metres at channel 6).

WARNINGS

Performance will be very much cable length sensitive. Note in the accompanying table how each set of channels has three cable lengths; optimized lower channel, optimized higher channel, mid-range. The variations are typically within +/- 20 mm. At channel 1 +/- 20mm is a length error of +/- 0.003% (3/10s of one percent). At channel 11, +/- 20mm is a length error of +/- 0.015 (one and a half percent). If both channels are off by 1.5%, the total length error is 3%. Phase errors (remember this is all about phase and phase cancellation) can be in the 10 degree region in the worst case. This suggests optrimizing for the weakest channel when in doubt.

No cable has a velocity of propagation factor of 100%. In coaxial cable common propagation factor length corrections are 66% (RG-11 solid core) to 79-82% (RG-59 foam and RG-6/U foam; 300 ohm twin lead and tubular) to 95% (300 ohm open wire). You must know the velocity of propagation (VF) of the cable you are using. If using Foam-7, for example, with a VF of 82% the combining length of cable will be .82 of the dimension shown in the length table. A 1% error here is substantial; and mistaking RG-6 for RG-6 Foam deadly (a difference between 3.536m cable length at .66 and 4.393m cable length at .82).

WILL IT WORK?

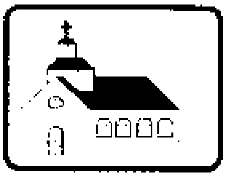
It should. Mike Fouhy and I will both appreciate feedback from those who experiment with the technique!

LENGTHS (BEFORE VELOCITY OF PROPAGATION FACTOR) THAT COMPUTE

CABLE LENGTH	LOW CH	HIGH CH.	CABLE LENGTH	LOW CH.	HIGH CH.
3.990m	6	11	7.134m	6	9
4.050m	5	11	7.390m	5	8
4.130m	5	10	9.390m	4	11
4.220m	4	10	*9.630m*	8	10
4.286m	4	9	9.968m	7	9
5.352m	7	11	10.703m	9	11
5.540m	6	10	10.715m	5	7
5.730m	5	9	*11.085m*	4	10
5.970m	4	8	11.110m	4	6
6.100m	4	7	16.250m	4	8
6.670m	8	11	25.460m	5	11
6.890m	7	10	32.485m	6	8

NO TV3??

THE TAUPO SOLUTION



Prepared From Material Submitted By:
Ian Foster, Lakeland Sight & Sound Ltd / TAUPO

Buried within the middle North Island ranges, on the northeast coastline of a lake of the same name, Taupo's beauty, fishing and access to dramatic mountains and pristine forests have helped push the community of 16,500 to the top of the tourism world. The topography which draws in the admirers comes at a price; hills and mountain ridges surrounding the lake and city shut out direct TV and FM radio reception from nearby centres such as Rotorua and Hamilton.

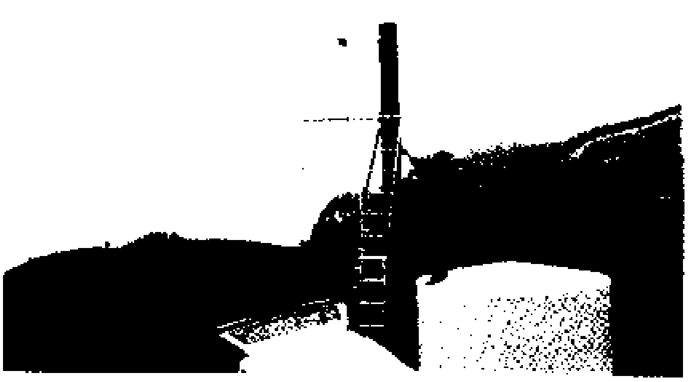
In 1977 Taupo, the community, was told, *"it will be years before you have TV2 reception."* While other communities accepted such notice with a whimper, Taupo took this as a challenge. At least a handful of local electronic pioneers, including **Ian Foster** of Lakeland Sight & Sound Ltd, understood that while Taupo itself might be shielded from direction reception, on one or more of the hills surrounding the town there was likely to be TV2 signal. A loosely organized group decided to find the signal and go from that point. We'll give you the bottom line first; six years before TV2 'officially arrived' in Taupo the community got TV2 reception by doing it themselves. Yes, we'll tell you how this happened.

Fast-forward now to 1986. The community wanted Concert FM but their position 'on the list' for expanded Concert FM service was so far down it could not even be estimated when it might happen. The roadblock to faster service was funding and so Taupo put its community organisations to work raising $15,000 to pay the costs of a 100 watt FM translator. Once again, while other communities wrung their hands in complaint and Concert FM enthusiasts settled for an occasional irate letter in the local newspaper decrying the Concert FM bureaucracy, Taupo was enjoying the service.

Fast forward again, this time to early 1991. TV3 was on the air and its many new programmes were the talk of the country. But not in Taupo; once again the community was shielded from direct reception (from the Ruru channel 9 transmitting site) and TV3's expansion list didn't even mention Taupo, when first issued. Bouyed by their success with earlier TV2 and Concert FM jousts with bureaucracy, off Foster and his volunteers headed again. This time they found +5 dBmV/65 dBuV of channel 9 Ruru signal on a hill near town. As Ian Foster notes, *"In Taupo we are not ones to wait for services to be provided."* And that's what this report is all about.

LEARNING FROM THE PAST

One of the earliest recorded 'incidents' where a town refused to wait for service occured in Rotorua. The year was 1961 and television was brand new in New Zealand. Government policy for the introduction of the new service was not clear; at least it was not clearly understood by people outside of the major centres such as Auckland. The technology to extend service into Rotorua was in hand long before the funds or the bureaucratic desire. The 'home built' translator, labourisly adapted from circuits



FOSTER AT WHAKAROA PRIVATE SITE

appearing in the (American) ARRL Handbook took shape and was placed on the air. But not for long; the Post Office authorities took a dim view of unlicensed transmitters, no matter how worthy the cause (D. Cobbe risked imprisonment by placing a 'pirate' translator on Mt. Ngongotaha; New Zealand's celebrated TV piracy pioneer).

Dozens of other clandestine installations followed; a few stayed on the air long enough to encourage locals to purchase TV sets, others lasted only days before the field forces from the Post Office swooped down to confiscate the gear. Foster and others in Taupo were very aware of this history when they set out to bring TV2 into Taupo in 1977. They decided on a less confrontational approach.

TV1 service was available; TV2 would be 'years', a matter of money Taupo was told. A community fund raising effort followed taking months to raise $1,000. Foster re- calls, "*The TV2 translator fund-raising went to the community as a whole, asking the families who would benefit to contribute. It took a long time to raise $1,000, which was alot of money in those days.*" With the money in hand, Taupo went to the-then translator licensing instal lation /authorisation authority; then called BCNZ. Much to the community disappoint- ment, BCNZ turned them down.

"*We can only guess that the BCNZ thought they should be the only ones to install or even contemplate installing translators. Their excuse at the time was that as Taupo only had an interim 100 watt TV1 unit, that TV2 should not be installed until the permanent TV1 translator was installed. We never understood this logic ... .*"

The community was disappointed; following months of raising money, they were suddenly told, "*No, you cannot have TV2.*" Desperate measures were considered.

"*We installed our own $1,000 0.5 watt translator. Our MP, Mr Ray La Varis, supported our actions and before the Post Office could confiscate the translator he negotiated a deal with the Postmaster General for our unit to stay on the air while the community raised $5,000 for a ten watt BCNZ installed unit.*" BCNZ capitulated when they sensed Taupo would help fund a 'real' translator.

And that was 1977. Finally, in 1983, two new NEC 500 watt transmitters were installed at Tuhingamata, the site of the TV1 translator. BCNZ policy in 1983 was to have equal power for both TV1 and 2 services at all sites (TV1 on channel 5, TV2 on channel 7).

Foster notes, "*Because we took community action and forced the issue with our own miniscule 0.5 watt unit, the events that followed insured that we had TV2 for 6 years (i.e.,* 1977-1983) *when otherwise Taupo would have done without TV2. The longer it took for the permanent TV1* (and finally TV2) *transmitters to be installed, the more we were convinced that we had done the best thing for Taupo.*"

The 0.5 watt unlicensed unit was installed on a hill overlooking Taupo owned by a friendly farmer.

The next challenge came when Concert FM's service was planning expansion leaving Taupo out in the noise again. This time the community raised $15,000 for a 100 watt unit in 1986. The bureaucrats were slowly getting the message;

by-pass Taupo, and the community would respond on its own.

Enter TV3. By 1990 the Lake Taupo region tourism business was becoming a major economic factor. The community must compete for tourism dollars with other nearby centres, such as Rotorua. Tourists might not select towns to stay in based upon available TV reception, but the motels in and around Taupo were uncomfortable having to tell holiday makers that TV3 was not available. Many Taupo motels countered by offering one and two channel in-house video movie systems.

"*When TV3 began from Ruru, we found we could get a good +5 dBmV/65 dBuV signal from a five element yagi on a hill near Taupo.*" notes Foster. There was a problem, however. The TV3 channel assigned to Taupo (11) was not at the time licensed for NICAM. "*If we converted channel 9 to 11 and retransmitted it, the imbedded NICAM signal on 9 would spill outside of the channel 11 bandwidth.*" It was one thing to flirt with pre-empting the eventual arrival of a channel 11 translator; quite another to radiate signals in a frequency spectum (230-231 MHz) which was not assigned to television service.

TV3's consulting engineering firm, Johnston, Dick & Associates, had a solution. TV3 planned a 100 watt UHF relay on channel 42 to feed Rotorua (and Taupo). The channel 42 transmitter (on Paeroa Range) could be designed to be NICAM free. The link went into operation in March 1991 and with it came another 'interim' community funded translator.

"*We discussed the interim unit with TV3 and they agreed to file for the license on our behalf and pay the license fee. The community raised the funds itself again, but we had learned that the fastest way to do it was to look for 'corporate sponsors'.*" Foster's firm, a private radio station and a major appliance store put up most of the money although there were general community donations as well. "*The BCL* (TV1,2) *site on Tuhingamata proved to be very expensive to locate on. We did some signal probing and settled on* Whakaroa *which happens to be superior* (better elevation, line of sight to more people over a wider area) *because we could deal with the owner. An 11KV line was situated within 700 metres of the summit. I had first approached the land owner for permission to site* Radio Rhema's *FM transmitter there. Subsequently,* KIS FM *also wanted to be at this site after they learned how much money BCL was asking for co-siting on* Tuhingamata. *We ran two 230V neutral screen underground cables to the summit, one for each transmitter. The present TV3 translator is operating from one of these.*

"*When we installed the AC lines the local power authority decreed we must not measure more than 2.5% voltage drop on the cables. The supply meters as well as the 11KV-230 transformer are located at the 11KV pole. With two FM transmitters at the site, we were going to have more drop than this with a* higher power *TV3 unit. That has now been negotiated: they say if we sustain more than 2.5% drop, that's our business and this clears the way to install* a permanent *TV3 200 watt channel 11 unit at the site in September using the 16mm KIS FM power line.*"

TV3, now pressing to expand coverage, has reached Taupo 'on the list' and they will benefit from the work done by also utilising the less expensive Whakaroa site. Taupo of course will have 10 dB stronger signals but in the interim they have enjoyed 2.5 years of TV3 which they otherwise would not have had. Foster also notes their DX Antenna channel 42 - 9 converter will be available for another community after September.

BOTTOM LINE

A community does not have to 'wait for TV' or any other service; Taupo has proven that. Foster suggests the TV dealers and appliance people take the lead to create a local society with a public meeting. "*If a community wants something bad enough, it can be done.*"

WHAT IS TECH BULLETIN?

Tech Bulletin is the five-time-per-year 'newsletter' created for consultancy clients of Robert B. Cooper. In recognition that VHF/UHF reception and transmission literature / data is often difficult to locate in New Zealand, we make this material available in the hope you as a stockist in television receiving equipment, or an installer of TV receivers or as an aerialist installer will benefit. This is done at the most reasonable cost possible in recognition that per-hour consultancy rates to assist those with television reception problems are unfortunately by their customized nature not affordable in most stockist or aerialist day to day reception situations. To avoid these higher costs associated with researching and answering specific answers to specific problems (on a one-question / one-response basis) Tech Bulletin employs an 'economy of scale' approach. Subject matter is chosen, researched, and presented in the Tech Bulletin format on a five-time-per year schedule.

Tech Bulletin is offered to TV stockists, aerialists and others with an interest in the subject on an annual subscription basis; see next page.

AND COOP'S TECHNOLOGY DIGEST?

As Tech Bulletin is devoted to reception techniques, Coop's Technology Digest is totally about the technology that will change your business (or put you OUT of business) in the coming few years. You are entitled to ONE free sample copy; write or FAX today.

TECH BULLETIN SCHEDULE - ISSUES RELEASED AND PLANNED

TB9301: Co-Channel (interference) elimination; antenna and phasing techniques. *[Issue now available]*

TB9302: Weak signal techniques, antenna + masthead practices. [*Issue now available*]

TB9303: UHF techniques, including construction guidance for low-cost UHF parabolic antennas to 6M diameter. [*Issue now available*]

TB9304: Identifying and correcting television interference problems. [*Issue in your hands*].

TB9305: Master/community aerial techniques on a budget; how New Zealand laws govern, how to design and build CATV systems, how to source equipment. *Note*: This is a two-issue series with part-two early in 1994. [*Release date 15-11-93*].

Each issue of TECH BULLETIN focuses on a single topic to provide a thorough schooling in the subject matter chosen. Additional assistance available on a consulting basis.

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TECH BULLETIN
ISSUE 9304:
INTERFERENCE

TECHNICAL DETAILS / NEW ZEALAND TELEVISION

New Zealand uses CCIR System B in the VHF band (bands I and III), System G in the UHF bands (bands IV and V). The only difference between 'B' and 'G' is the 7 MHz channel width of B and the 8 MHz channel width of G. Stereo sound follows the NICAM format as will future multichannel sound services. This is a digital DQPSK modulation scheme with a carrier 5.850 MHz above vision. TELETEXT follows the UK model. The vision-to-analogue sound ratio is 10 dB except where NICAM is in use; here the ratio of vision carrier to aural carrier is -13 dB while the NICAM carrier operates -20 dB reference the vision carrier. Approximately 70% of transmitting sites utilize a visual carrier offset of from +/- 10.4 kHz to +/- 23.4 kHz (see TECH BULLETIN 9301). The SKY Network pay-TV channels utilize the Thompson Vidicrypt encryption system. Other UHF channels are 'free to air'. UHF planning allows room for as many as nine (9) nationwide television networks.

Scanning Lines - 625
Line Rate - 15.625 kHz
Fields per Second - 50
Vestigial Sideband - 0.75 MHz
Colour Subcarrier - 4.43361875 MHz

Vision-Sound Spacing - 5.5 (5.4996) MHz
Analogue Sound Deviation - +/- 50 kHz
Vision Modulation - Negative (going)
Colour System - PAL
NICAM Sound Modulation - Digital DQPSK

(Data courtesy Broadcast Communications, Ltd; current to 22/06/93)